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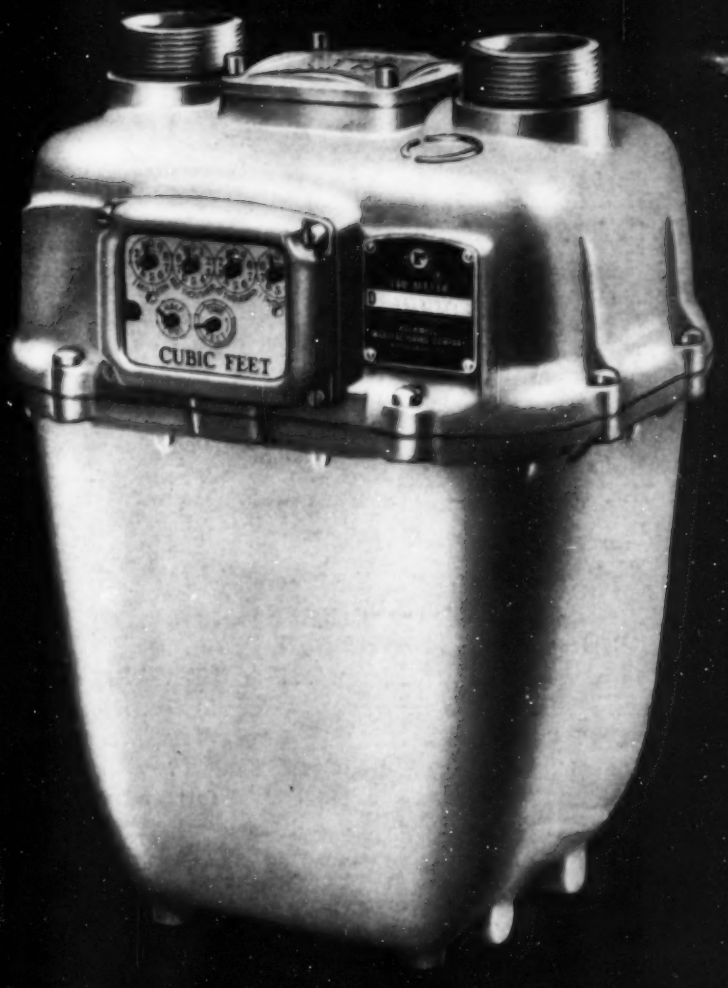

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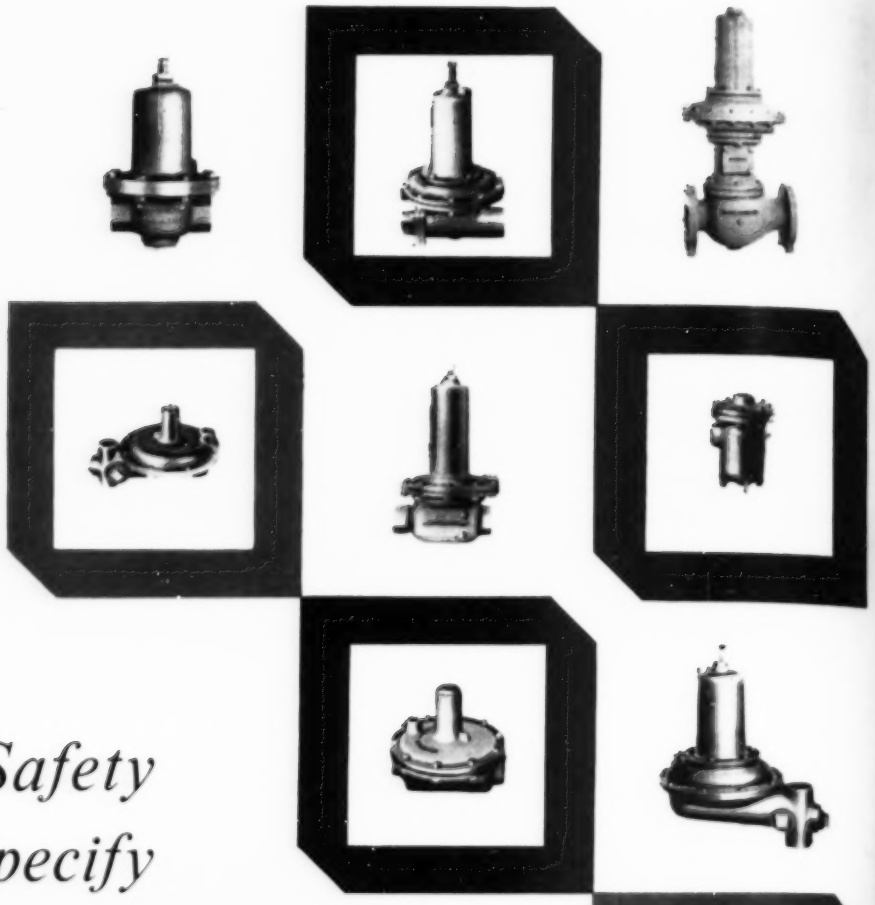

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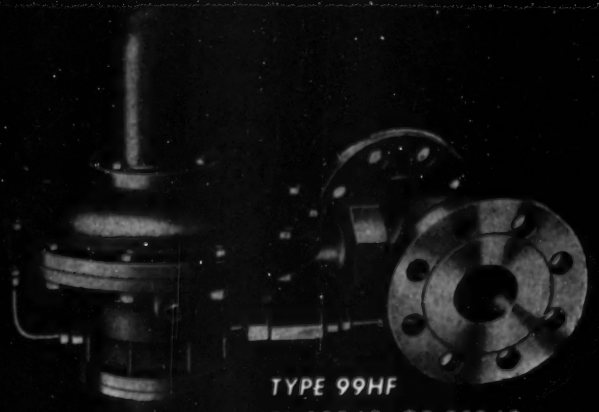

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GAS Thermally Thinking

The big news is regulation

JUST keeping abreast of the news developments in the gas industry these days, without even trying to keep ahead of them, is a major undertaking. So many things are happening simultaneously on so many fronts; and the temptation is great to long a little for the good old days when the business not only held a lot less opportunity, but also a lot fewer headaches. When a 1000-mile, 20-in. pipeline, for example, was one of the modern wonders of the world.

What this all points up, of course, is clear: Gas is big news, like it or not, any "public relations" policy that seeks to suppress this news is not only anachronistic—it's dead as a dodo.

Regulation is the biggest news today, with Washington the focal point. Consider, for example, the report of the cabinet committee on fuels, which is yet to be released, but is presumed to be of considerable importance; the several bills to amend the Natural Gas Act, both those favorable to producers and to the pipeline industry, and those which would impose even greater restrictions upon operations; the Kuykendall recommendations to Congress, wherein the FPC chairman asked for 19 new powers; the Heselton bill to set up safety regulations over the gas industry, which has grown whiskers through several sessions; the President's superhighway proposal, which may cost utilities tens of millions of dollars; the import problem as exemplified in the Northern Natural case; the legal wrangles developing in the Skelly-Lone Star hearings.

Actually, these are only a few of the many newsworthy events taking place throughout the nation today. The important point is that there's not a one of them that isn't loaded with propaganda dynamite. The always-dependable Columnist Tom Stokes and others of his "liberal" stripe can, and do, make dripping copy out of any one they select, any day in the week. Just how much of this stuff do the people believe?

Ben Fairless of United States Steel provided a clue in a recent address before the Public Relations Society. While congratulating the members of this relatively new profession for the manner in which they have elevated business in the eyes of the public over the past 20 years, from a point where it was viewed as the lowest form of human life, he nevertheless finds considerable cause for concern in the present state of public opinion. Citing a poll of manual and white collar workers, made several months previously, he pointed with considerable satisfaction to the stature of business leaders as seen through the eyes of those polled; but one finding disturbs him greatly:

"When asked which group of leaders had done the most to protect freedom of the individual in this country, the overwhelming majority of these industrial workers gave the credit entirely to government officials."

Commented Mr. Fairless:

"If they had been asked who had done the most to protect our system of free competitive enterprise, I have no doubt that they would have been almost unanimous in saying that business leaders were responsible for that; but obviously, they seem to think that economic freedom and individual liberty are two entirely different things—that it is possible to surrender one and still retain the other."

Would these same persons believe it is possible to take away what economic freedom the gas industry now enjoys and still retain individual liberty? Obviously they would, and even more emphatically than in the case of presently non-regulated enterprise. Arguments for yet tighter controls have a ring of truth, no matter how specious they may be, for they are presented to minds that have been conditioned to ask only, "Why not regulate?" We may have come a long way from the early days of the New Deal, but there are still many who cannot see a parallel in wartime OPA and rationing and peacetime super-regulation of certain industries—who cannot distinguish between anti-trust regulation and Socialism. They must someday ask, "Why regulate?" but until they do, all industries will have a lot of fence mending to do.

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highlights

GAS SPOT NEWS, TRENDS, COMMENT ON GAS INDUSTRY AFFAIRS

Pacific Northwest takes its case to the SEC

In late February, Pacific was scheduled to file a registration statement with the securities commission, indicating that financing hurdles have been cleared. The El Paso and Westcoast applications for cooperative pipeline ventures will be filed with the Federal Power Commission in late March or early April, according to present plans.

Hoppers bulging with amendatory legislation

Not one but several bills to change the Natural Gas Act to free producers from regulation were introduced in the House last month. One legislator would go a step further and write the "fair field price" rate method into the law. But some consumer states are just as determined to stick the industry with depreciated original cost; assuming that the producers will continue to be regulated, these legislators would extend this principle to cover rate basing methods for producers as well as producing pipeline companies.

Cabinet committee still sitting on its fuels report

At presstime, there was still no word from the President's committee as to when its fuels study would be released. Insiders obviously feel this is an important document, undoubtedly more consequential than the scholarly but not-too-conclusive Paley report of a few years back. Evidence of this lies in the fact that not only did FPC Chairman Kuykendall defer giving Congress his views on producer regulation pending release of the report, but the sponsors of amendatory bills also tried to stall until it is published. In their case, however, the suspense must have proved too great.

Old issues raised in Northern Natural hearings

Northern Natural wants to import gas from the Trans-Canada line at the Manitoba border, but considerable consumer opposition has developed. The price of 30½ cents is meeting resistance. Present customers don't want to help pay the bill for expansion. Coalmen and railroad men are fighting importation, as usual; and the argument used in the Pacific Northwest case to the effect that Canada might at any time shut off the flow is being cited. But Northern is intrigued with the idea of obtaining sources in opposite directions from its system similar to the arrangement proposed in the Northwest. Besides, the company would pick up a trillion feet of reserves, giving it a total in excess of 10 trillion, enough for 30 years. And 373 communities would be receiving gas from the Omaha firm.

Milwaukee Gas to be "investigated"

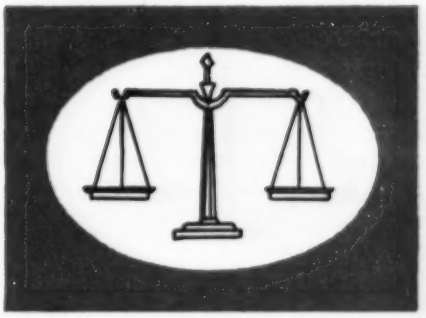
The Wisconsin PSC has ordered a probe of Milwaukee Gas Light Co. upon a complaint of Colonial Tanning Co., that the utility had served 30-day notice of intention to discontinue gas service until further notice. Colonial is an interruptible customer; however, the PSC thought there was "good cause" for making the investigation. About 50 other interruptible customers were served similar notices. President Dudley B. W. Brown explained that it was simply a matter of the supply line being unable to meet heavy winter demand; but PSC Chairman Durfee was quoted as charging that Phillips Petroleum Co., producer supplying the pipeline system of Michigan-Wisconsin Pipe Line Co., which brings the gas to Milwaukee, had threatened to shut off natural gas to Wisconsin as a reprisal against state officials who helped push through the Phillips decision. Phillips immediately termed the charge false.

New piping standard is off the press

A second edition (1954) of American Standards Installation of Gas Piping and Gas Appliances in Buildings, Z21.30, in pocket size, has been published by the AGA Laboratories. Publication as an American Standard followed approval by the American Standards Association last Nov. 29. The text has been adopted by the National Fire Protection Association and the National Board of Fire Underwriters and is the same as that published in NFPA No. 54, 1954 and NBFU No. 54, 1954.

*regulatory and legislative trends

Balancing of interests seen in current regulatory activity



RECENTLY legislators and regulatory commissions have made significant progress in solving new problems of balancing the interest of utility consumers and investors. The future of gas utilities will be affected by that progress.

Federal legislation

Meritorious legislation by Congress progressed two steps. Congress removed the costly and unnecessary duplicate federal and state regulation of local gas companies which receive interstate gas; and it relieved certificated gas companies from involuntary and incompatible common carrier obligations when the pipeline crossed government land.

The Hinshaw amendment to the Natural Gas Act became effective March 27, 1954. For a local natural gas company to qualify for exemption from federal regulations, the gas must be received at the state line and ultimately consumed within that state; and the rates, service and facilities of that company must be under state regulation.

The Butler amendment to the Mineral Leasing Act became effective Aug. 12, 1953. The purpose of this legislation was to permit gas companies subject to federal regulation under the Natural Gas Act, or utilities subject to state regulation, to cross United States government land without incurring the obligation to become a common carrier. A natural gas pipeline is designed and operated to provide a continuous fuel service to its customers and not for the purpose of providing transportation of gas owned by others. This legislation did not infringe upon the authority of the Secretary of the Interior to administer the Public Lands involved or of the FPC to regulate the interstate natural gas pipelines crossing these lands.

Rate making

The majority of states still adopt the original cost of gas properties less accrued depreciation as the rate base for rate making. In the present "fair-value states" reproduction cost estimates, or a combination of other methods indicating current value of facilities devoted to the gas utility service, are employed as rate bases.

The majority of regulatory commissions have cut the amount of requested working cash allowance to the extent that tax accruals made for future payment offset the current need for working cash.

During the current inflationary period, the terms "attrition" and "erosion" have been applied to describe the deterioration in the realized rate of return resulting from additions and replacements at a higher cost-per-customer than the original cost of existing facilities. Several methods of measuring and allowing for this attrition have been employed. One commission projected the rate base forward for a six-month period and estimated the deficiency in return over an 18-month period. Another commission has adopted the novel approach of assessing against the new customers, whose demands require the construction of high-cost plant, the excess over average original cost.

One of the larger state commissions has compensated for the recognized declining trend in rate of return by making an additional allowance in the rate of return to the basic rate of return found to be reasonable for the future. This was done so that the gas company could earn a fair return next year.

One of the currently vital subjects is the rapid amortization of facilities, which is optional under recent federal income tax law. Two states recently joined the group of regulatory agencies that require that depreciation be accrued on the basis of normal service lives of property with the savings in taxes during the rapid amortization period placed in special accounts for use after amortization is completed. The FPC ruled that it must recognize the clear intent of Congress, which was not to forgive, but merely to postpone, the payment of federal income taxes, and that utility rates should not be lowered because of reduced income taxes paid in the five-year amortization period.

The regulatory agencies have approached a unanimity of opinion that charitable contributions by utilities should not be assessed against the rate payers.

Most jurisdictions continue to allow the amortization of the cost to convert customer appliances from mnaufactured gas to mixed or natural gas. In addition, the cost of abandoned manufactured gas facilities has been allowed to be amortized over a period of years, because such items are excluded from the rate base. The subject of amortizing conversion costs is very much alive in New England with the recent delivery of natural gas to that region.

With so many major increases in the rates charged by interstate pipeline companies for natural gas delivered to local distributing companies, it has become important for the retailing companies to obtain compensating rates concurrently or suffer an unrecoverable loss. Twenty-four states have protected their local distributing companies by authorizing purchased-gas adjustment provisions in rate schedules, which change retail rates automatically to the extent of increases or decreases in the wholesale price paid for natural gas.

The more than 4000 natural gas producers who are currently under rate regulation by the Federal Power Commission are concerned over whether a utility formula or a risk recognition formula will be employed. In January 1955 the Federal Power Commission re-

***Contributed comment on current developments by an expert in the field, to be a frequent feature in GAS for 1955.**

ceived suggestions on principles and methods to be applied in the fixing of rates to be charged by independent producers for natural gas sold in interstate commerce.

Suggestions submitted covered a wide range of proposals and there were differences of opinion as to how this matter should be treated even among those representing similar interests. However, in a general way, the suggestions were in these categories:

(1) the spokesmen for independent producers generally urged that the FPC accept the contracts made as a result of arm's length bargaining as fair and reasonable in themselves;

(2) the pipeline company spokesmen differed considerably in their suggestions, one supporting the position of the independent producers, others advocating a modified fair field price proposal, another urging acceptance of present contracts made at arm's length except that favored nation and certain types of escalation should be barred, and still another suggesting that the FPC make a complete study of the matter while awaiting Congressional action with the thought that if Congress doesn't clarify the matter the FPC then would be in a better position to determine the proper method;

(3) the distribution company representatives primarily advocated a modification of the fair field-price formula for new contracts, with a freezing of the June 7, 1954 price on existing contracts except where the producer, in formal hearings, could show justification for an increase;

(4) those speaking for the cities mainly advocated application of the utility original cost formula;

(5) state commission spokesmen called for a thorough FPC investigation of the matter, with Wisconsin urging original cost. Most of those appearing, with the exception of the independent producer representatives, expressed determined opposition to favored nation and spiral-type escalation clauses.

Regulatory delay

During the recent period of increasing wages and cost of materials the utilities have incurred great losses in revenue while waiting for the regulatory agencies to grant rate relief. There is an inevitable delay in our rate making procedure, but the waiting of one or two years for justified rate relief is inexcusable. There is a noticeable tendency now in the state commissions to reduce the delays in deciding rate cases.

Commissioner Blackstock of the Province of Alberta, Canada, proposed the use of a "transitional loss allowance" to compensate the utilities for the serious delays in rate case proceedings. The reactions of the various regulatory commissions to this suggestion were not favorable. The approach that has been adopted is the practical one of streamlining rate case procedure in those jurisdictions where there is no statutory provision for making prompt contingent rate increases subject to refund when final rates are fixed. Some commissions practice the service of exhibits sufficiently in advance of the hearing so that cross-examination can be completed without a long recess between hearings. Another method has been to obtain agreement among the adversaries on major items such as original cost, accrued depreciation, materials and supplies, working cash, volume of gas used per meter under normal temperature conditions, number of active meters, the cost and volume of purchased gas and non-debatable operating expenses. There is seldom agreement on what constitutes a fair return, or on how the total rate increase should be assessed against the various classes of customers. A review of the cases reveals that an unreasonable delay during the past year was the exception. Most rate cases have been decided within six months after the filing of the application. In addition, the volume of cases has been lighter than for many years.

Service

A torrid issue currently is whether a utility commission has the right to condition a rate increase upon the improvement of service. Some commissions have penalized utilities by reduced rates when the service has been considered unsatisfactory. Some courts have reversed the commissions. A Michigan court in reviewing a commission decision that granted one-half of a requested rate increase ruled that an adequate and non-confiscatory rate cannot be denied because of unsatisfactory service. The Florida supreme court rendered a consistent companion decision and ruled that rate making and regulation of service should be in separate proceedings.

Capital structure and securities

The financial vitality of a gas company is highly important in current times to enable it to attract necessary capital on reasonable terms. Gas companies are in competition with other utilities and with non-regulated industry for the investors' money. Capital structure affects cost of new capital.

The public utility financing task is emphasized by the fact that the amount of capital raised during the past 11 years equaled almost one-half of all the money obtained by American industry from investors through new security issues during the period after World War II.

According to the Secretary of Commerce, one-fourth of the money invested in all industry in this nation is invested in regulated industry.

In considering the sale of stock several states have ruled that they have authority to require a sales price greater than the par value of the stock. However, the North Carolina supreme court decided in such a case that the commission must hear evidence supporting the price, and must find that a sale above par is in the public interest.

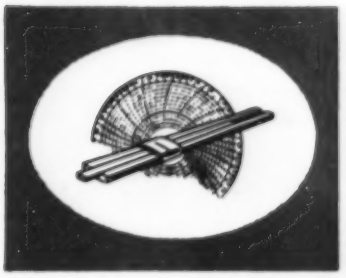
Some regulatory commissions have frowned upon the current tendency to obtain new money by the issuance of debt securities which results in a large debt ratio in the capital structure.

During 1954, the gas industry sold $1,390,000,000 in securities, including refunding issues. Debt securities accounted for 94% of the total.

Today a critical analysis of utility financing, as in the 1920's, is necessary to foster the financial strength of these essential service companies in the future. Good credit, if once lost, is seldom regained. Loss of credit has two results. First, it will increase the cost of new money to the utility, and second, it will gradually impair the quality of utility service.

Twenty years ago we experienced a devastating business depression. At the same time, we witnessed the financial failure of railroads, which was attributed to unsound and heavy debt financing. Enlightened regulatory commissions today are cautioning about higher debt ratios and the declining equity components in capital structures of utilities. Yesterday's mistake should not be repeated, and the committee on corporate finance of the NARUC has declared that: "A revival of sound financial practices is imperative, the more so because of the current inflationary trend. Gains which appear to be realized today from low interest rates and tax savings may prove to be illusory."

technical trends



• By GUY CORFIELD

Plastic "principles"

The plastics industry, contemplating its phenomenal growth and expansion, is realizing that it must develop and preserve a business and technical integrity so as to merit and retain the confidence of its customers. Accordingly, it has written the following "statement of principles by the plastics industry":

1. Understand thoroughly the properties and limitations of all plastic materials handled by us;

2. Apply the correct plastic materials to all industrial end uses, designing and engineering them for maximum value, performance and safety;

3. Use great care to select the correct plastic materials for all consumer items, designing and engineering them to ensure value, satisfaction, safety, and pleasure to all users;

4. Sell plastic materials, and all industrial and consumer items made therefrom, on the merits of the materials, applications and design, and free of extravagant, insupportable claims.

The gas industry, which, as indicated by its answer to the questionnaire shown elsewhere in this issue, is in general contemplating the use of plastic pipe with expectation but caution, will sound a hearty "Amen" to these principles.

Ocean vs. land production

Oil and gas are now being actively produced in the Gulf of Mexico offshore area along the Texas and Louisiana coast, from 500 wells in quantities of approximately 47,000 bbl of oil and 138 MMcf gas daily, with 44 gas wells shut in. The production shelf, an extension of the on-shore low lying area, slopes gradually from about 600 ft above to 600 ft below sea level, before it drops rapidly to ocean depths. The land area of approximately 39,000 sq miles is a strip 20 to 90 miles wide extending from the Rio Grande to the Mississippi rivers and the corresponding submerged area would extend outward to a depth of about 160 ft.

While there is, of course, much more experience with land drilling and production than with offshore operations, some approximate cost figures are developing for the latter and the comparisons are interesting. There are three general methods used for drilling offshore wells—the small (or medium) platform with floating tender, the self-contained platform, and the mobile submersible barge. The first method has so far proved to be the most economical and flexible, and therefore has been the most widely used; the latter method, involving a barge which has legs than can be lowered to rest on the bottom for stable support, has so far not been used at water depths greater than 40 ft.

The necessity for across-water transportation and communications makes offshore drilling unavoidably expensive. A protected shore base is required to provide office, living quarters, warehouse, equipment and oil storage, etc.; three power boats are also necessary, large enough (about 75 ft) to transport workmen and small supplies, one on standby at the rig, one in transit and one spare; a large work boat is also needed to carry heavy equipment, water, mud, etc., and tug boats are required at times; also there is need of radio and marine telephone communication. Because of all this the investment for an offshore drilling operation, including the land base, totals between $2 and $4 million, of which only from $100,000 to $400,000 is salvageable in case of a dry hole or other abandonment.

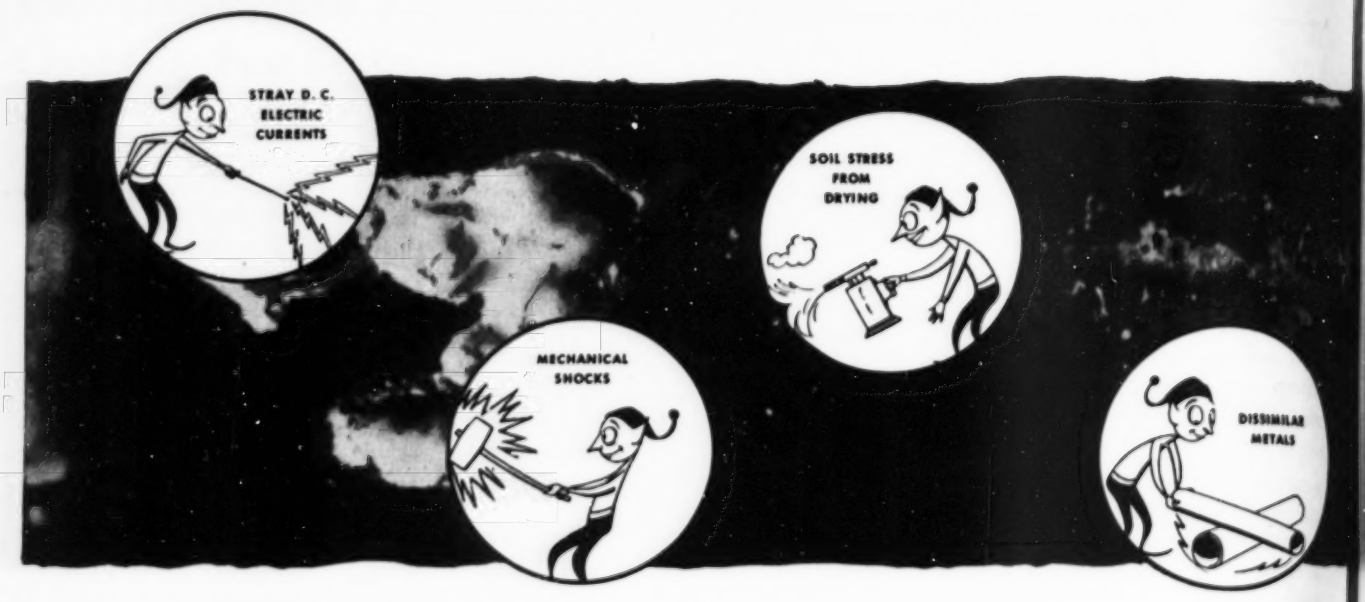
The costs of drilling 11 000 ft dry holes offshore varies from $350,000 to $500,000, and completing producing wells varies from $400,000 to $650,000. Compared to this, a dry hole on the land strip costs about $150,000, and a completed well about $200,000. It can thus be seen that marine drilling and production are "blue chip" undertakings.

For the immediate handling and storage of produced oil, three methods have been developed. One is to pass the oil through minimum separator equipment on the production platform, into a 5000- to 10,000-bbl barge moored alongside. A second is to store the oil on the platform, with periodic pickup by barges or tanker. The third, and the most economical under favorable conditions (relatively close to shore, substantial production, etc.), is to have minimum facilities on the platform and run the oil to shore by pipeline. Per barrel of oil, the offshore production costs vary from 50 to 80 cents, which is about double the production costs of land operations.

Where gas and condensate are produced they are separated on the platform or on an adjacent platform, and the gas dehydrated. The two products are then piped to shore. The avoidance of storage offshore makes this operation reasonably economical and approaching the costs of land production, but reliable comparison of cost does not seem to be available.

When trying to visualize offshore operations one always speculates on the effect of wind and waves, particularly when they are of hurricane proportions. The equipment can be built to withstand the fiercest storms but operations may have to be suspended and shutdowns are costly not only because of lost production but because, when drilling, costs go on at about 80% of operating level. However, records over the past seven years show that hurricanes have been responsible for less than 1% loss of operating days, and "non-hurricane" weather has caused only about 2.3% loss of operating time.

6 DRESSER PRODUCTS THESE MAJOR CAUSES



Gas Men Seek Improved Insulating Methods . . . Help Develop Dresser Insulating Products

Whenever utility men get together, corrosion almost always heads the list for discussion—how to best protect their company's huge investment in underground piping. Satisfied that insulated pipe effectively resists corrosion, they are naturally interested in talking over improved insulating methods, new insulating applications.

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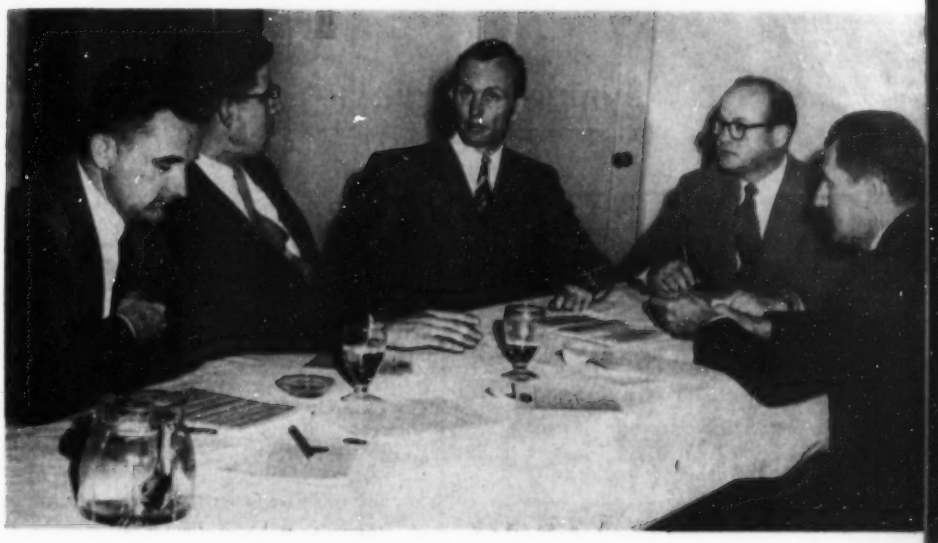


At the first luncheon-symposium in Los Angeles last month were (from left) Robert I. Moore, Southern California Gas Co.; Robert C. Moore, Standard Electric Time Co.; Donald W. Pendery, International Business Machines Corp.; J. Fred Ebdon and Frank Chapman, GAS magazine.

By J. FRED EBDON
Managing Editor

Personnel and organizational requirements for engineering applications of digital computers

TODAY, many operating gas companies are at the crossroads in the process of deciding whether to buy or rent digital high-speed computing equipment. So the discussion of personnel and organization matters with which they will be faced when they actually begin using this type of equipment is particularly timely now.

Certainly, it is well known that computers will perform the bread-and-butter work in the solution of involved numerical problems very rapidly, but it is also well known that a human component is required to furnish the input information. The formation of a staff in such a way as to provide the unity of purpose and method required for the solution of an engineering problem from perception to completion is one of the major unknowns to be determined.

How many men will be required to prepare, operate, and supervise the flow of engineering data and information through an electronic computer? Should a separate staff be assigned to such work or should several existing sections of the organization lend a portion of their personnel to the computation process? Just what, in the way of organizational readjustment, is involved when a company switches from conventional to electronic calculating methods? These, and many others, are the unknowns that flash through the minds of policy-level people contemplating the application of automation techniques to a part of their engineering calculations. Perhaps the best guidance to the answers can be found in the opinions of some of the people in the gas industry who have experience and ideas related to the problems.

GAS choose the symposium as the medium for the interchange of ideas on personnel and organizational problems associated with the application of digital computing equipment. The ideas expressed by the panel members are their own and are given as their unselfish efforts to aid in the dissemination of information gained through experience with digital computers or detailed studies into their utility and operation. They do not speak, necessarily, for their companies or for *GAS*—they do not speak as unquestionable experts, but they do speak as persons interested in the proper and efficient application of modern methods to gas engineering mathematics.

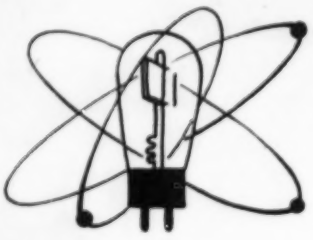
In this issue — starting on pages 58 and 127

Corrosion prevention — plastic pipe section

Four articles of timely interest on use of plastic piping in the gas industry, characteristics of two principal plastics materials, plastic pipe installation methods, and progress toward developing standards; an economic study on sources of cathodic protection power; and, in the pipeline section, an examination of modern holiday detectors and a discussion of soil resistivity in establishing corrosion control.

GAS
MARCH 1955

Symposium on the use of digital computers in the gas industry



Q. To what extent are digital computers currently being used in gas engineering, and what is their future potential in this field?

The distribution group (John P. Clennon of Peoples Gas Light & Coke and Robert I. Moore of Southern California Gas Co.) felt that the most obvious application of high-speed computing equipment in distribution engineering is the analysis of gas flow in pipe networks.* These usually involve the determination of the most efficient method for improving a distribution plant by physical additions to meet the increasing demand for larger volume deliveries of gas and the elimination of low pressure areas. Practically, these additions might involve improvements in the form of high, intermediate, or utilization pressure mains, or a combination thereof. It has been established that digital computers are capable of solving problems of this type by use of the Hardy Cross or some other method for the reduction and solution of a series of simultaneous, non-linear equations; however, Mr. Clennon believes that it is well to evaluate the high hourly costs of digital computer operation for problems that perhaps could be solved more economically by using conventional methods. In making repeated calculations required for the determination of the optimum modification necessary to produce predetermined results in pipe networks, electronic equipment seems to have no peer.

Mr. Moore pointed out that the processing of pipe condition data is potentially the most valuable application of computers in distribution operations. This would probably involve the recording of an identification code, length, diameter, soil type with pertinent corrosion properties, and the installation date for each size of pipe on each work order. Appropriate storage space would have to be provided for these data. The evaluation program would be based on the rapid and accurate calculating ability of the computer, and would be designed to select the proper corrosion formula, which would, in turn, be based on the soil type and diameter, etc. Then, on the basis of pipe condition reports, the computer would calculate the replacement date. Also, the computer could be programmed to supply totals, by sizes and years, of future replacement requirements.

In carrying his proposed program

*GAS, August 1953, p. 27.
GAS, February 1955, p. 45.

EDITOR'S REPORT

This first symposium on computers is one of a series on the subject to be conducted by the editors and published in GAS during 1955. The series was introduced by a general discussion of equipment and applications, published in the January issue (see "Digital Computers: Their Application to the Gas Industry's Engineering Problems," by J. Fred Ebdon, starting on page 109).

Five engineers, four from the gas industry and one representative of a computer manufacturer, participated in this study. They were:

Kenneth G. Ares, supervisor, computer section, El Paso (Texas) Natural Gas Co. (pipeliner); John P. Clennon, senior engineer, Peoples Gas Light & Coke Co., Chicago (distributor); Robert I. Moore, staff aide, engineering department, Southern California Gas Co., Los Angeles (distributor); W. F. Naeher, supervisor, methods and procedures department, Transcontinental Gas Pipe Line Corp., Houston (pipeliner); Donald W. Pendery, field manager, applied science division, International Business Machines Corp., Los Angeles (manufacturer).

Guests at Los Angeles luncheon-symposium: Frank Chapman, editor-manager, GAS; J. Fred Ebdon, managing editor, GAS; and Robert C. Moore, engineering consultant, Standard Electric Time Co., Springfield, Mass. (manufacturer, analogue equipment.)

The symposium was conducted by correspondence and personal contact, and was rounded out by a luncheon meeting held in Los Angeles Jan. 28, at which Mr. Moore and Mr. Pendery were present. A special guest, Robert C. Moore, engineering consultant of Standard Electric Time Co., Springfield, Mass., a manufacturer of analogue computers, sat in. GAS was represented by the author and Frank Chapman, editor-manager. At this conference, answers to symposium questions were analyzed and the questions themselves given further study in the light of these responses.

Future conferences are scheduled for Chicago in March and Houston in May; and there will be others later in the year. While attendance must be limited to a convenient and "workable" number, it is not restricted to panel members alone, and anyone with a valid interest in the subject of computers is invited to put in his bid for a place. Requests should be addressed to the editors of GAS.

As a guide to the staff in planning future symposia, it would be helpful if readers would submit questions they might have pertinent to the subject.

The whole-hearted cooperation of the panel members for the initial symposium was greatly appreciated. Considerable time was devoted willingly to the project, and the participants were eager to aid the staff in the dissemination of information about a subject that is relatively new to the gas industry.

The next symposium will be devoted to the subject of how electronic computers, both of the digital and analogue types, may be applied to network analysis and other engineering problems in gas distribution operation. The March meeting in Chicago will round out the consideration of the subject, so the prompt submission of topics and questions from readers of GAS is urged.

further, Mr. Moore said: "Cost data could be introduced, and the computer could calculate the estimated cost of replacements, and such factors as present value, annual fixed costs, etc. The machine could also be programmed to make accurate repair or replacement decisions." He feels that the latter sentence is worthy of emphasis.

A refinement to this pipe condition analysis would be the use of mark-sense cards that would make it possible for pencil marks applied to appropriate locations on IBM-type cards to be read electronically and punched into other cards, which would be in-put to the machine. The mark-sense cards could be prepared in the division office by the clerk or engineering assistant who reviews the pipe condition reports received from the field.

Load studies and predictions seem to be another field in which digital computers could be advantageously used. Mr. Moore mentioned that as the problem presents itself today, it is a manipulation of meter counts and load experience information, and the amount of arithmetic involved in utilizing the source data that his company has currently accumulated is relatively small, so the use of the electronic equipment for processing these data could not be justified. "However, it should be recognized that all piping design done today, or the improved design that might be achieved using a digital computer, depends for its true value on the accuracy of load predictions," he said, "and this fact emphasizes the need for improved methods of collecting load data."

Mr. Clennon suggests that computers might solve the sort of managerial problems that are usually referred to the engineering department staff, such as those where masses of data must be processed in order to bring out hidden trends and concealed facts. Such data as workers' performance, unit cost of service, use and maintenance of automotive fleets, material inventory, and service pipe records would fall in this category.

Other distribution applications have been suggested and used.* No doubt, the distribution companies are just on the threshold of the development of new applications that will aid the engineer and free him from some of the routine associated with modern utility engineering.

Pipeline companies are evidently further along in the application of machines to solve mass-mathematics electronically. Mr. Ares is using this equipment for the solution of problems related to design, construction, and operations of a large transmission system. Specifically, some of the calculations being accomplished rapidly and efficiently are:

(1) Pipeline design.
(2) Pipeline operation.
(3) Compressor design.
(4) Hydrocarbon process calculations.
(5) Mass-spectrometric data reduction.
(6) Reduction of civil engineering survey notes.
(7) Statistical and economic analysis.

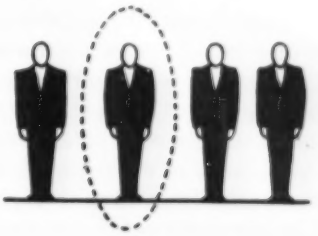
It should be pointed out that these are not projected uses: they are routine operational engineering applications where the equipment is producing the kind of results that are winning company-wide approval.

Mr. Naeher reported that his company does many accounting operations on its digital computing equipment, but in addition the following engineering problems are currently being solved on an operational, rather than experimental, basis:

(1) Gas volume calculations.
(2) Flow and line pack, using the Panhandle formula.
(3) Line balance, involving conversion of pressure bases.
(4) In-place gas reserves.

In addition, he is concentrating on a study to develop the use of the electronic machines on construction engineering problems which involve the amount of gas required to develop certain horsepower based on the amount of gas needed in the market areas. Again, these are actual functional applications that have risen from the realm of experimentation to take their place in the day-to-day activities of the company's engineering work.

The computer manufacturer's views on the subject of applications were given by Mr. Pendery. He related that in addition to the applications mentioned by the other panel members, harmonic analysis and correlation analysis were being done in the gas industry with the high-speed methods. In addition, he believes that many problems well suited to automatic computing can be found in the production phase, such as reservoir analysis, and in the operation phase, such as scheduling.*



Q How many persons, having what type of qualifications and duties, are being used directly or indirectly in computer operations?

This question applies to the people being used for computer operations in the particular companies represented by the individual panel members. John Clennon presented the unique plan his company has formulated for training personnel in the theory and operation of digital computers, set up in conjunction with the Armour Research Foundation. A total of 30 employees from the supervisory level, representing all divisions, have been given the course during the last two years. The engineering department sent to the training school four men who represented a cross section of the engineering department's functions. "It is believed that two of the four men from the engineering department could supply all the necessary information and data for computations from a computer," Mr. Clennon said.

In Mr. Ares' company, the persons who are directly connected with the operation of computing equipment are those assigned to a computer section. At

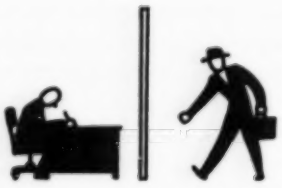
John Clennon of Peoples Gas suggests that computers might solve the sort of managerial problems that are usually referred to the engineering department staff.

*GAS, January 1955, p. 109.

*GAS, January 1955, p. 113.

the present time, this complement consists of four people, two mathematicians, one computer operator, and one key punch operator. The number of people indirectly concerned is rather indefinite because several of the engineers within the company from time to time plan and lay out problems for the computer; and, in some cases, they lend their services for programming specific problems.

In the setup with which Mr. Naeher works, engineering problems, as well as other problems, are first brought to the attention of the methods department. The three members of this segment of the company analyze the problem and make any needed tests to evolve the proper solution to it. This work might include programming, wiring, operating the machine, etc., in conjunction with the tests and investigation of the problem's properties. After the conclusions have been reached and the methods approved, the tabulating department (with five trained tabulating operators) is responsible for scheduling the work and carrying out the computations.



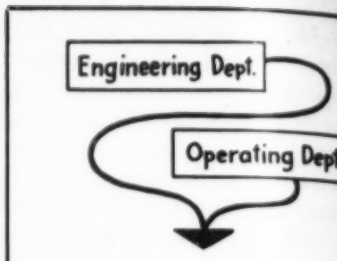
Q. Should supervisory personnel be enlisted from within the gas company or from the outside? Is it best practice to take computer-trained personnel and teach them the gas business or to take experienced gas people and teach them to use digital computers?

All of the panel, except Mr. Ares, expressed the opinion that supervisory-level personnel, experienced in the company's over-all operations, should be drawn from the company. This group indicated that one of the main obstacles to be overcome when automatic computing equipment is being installed is knowing what problems can be solved, how they can best be solved from the company's point of view, and what data are available or where to go to get required data. Further, they feel that personnel who are familiar with the gas business when the computing program is started are in a much better position to recognize potential applications. They all made the point that gas companies have engineers who are perfectly capable of learning the computer techniques in a minimum of time, and most, if not all, of the computer manufacturers offer training facilities.

Mr. Ares expressed another view on this subject: "In my opinion, the supervisory personnel of a computer group should be enlisted from the ranks of those trained in the programming and operation of digital computers. I think that these people should start to work at least six months prior to the arrival of the calculating machinery, so as to learn something of the nature of the problems that are to be solved. One of the most important items to keep in mind is that the machine approach to an engineering problem is often quite different from the manual approach. Personnel other than the supervisor should be selected from the company personnel. If possible, they should be selected from each of the major fields in which machine computations are to be performed," said Mr. Ares.

In Mr. Pendery's opinion it is best to train company engineers in the use of the digital calculators, but he believes that the transition from manual to machine methods can be considerably speeded if at least one person with computer experience is employed.

Mr. Naeher reports that his company (Transcontinental) is studying the use of electronic machines on construction engineering problems.



Q. If personnel is recruited from the outside, what requirements should be set up? If taken from the company, should they come from the engineering or operating levels?

The panel feels that if it is necessary to draw some of the computer personnel from the outside, experience in programming and operating some type of digital computer should be sought; however, the particular size or type of the computer on which the experience was gained is not significant. Of course, experience on a machine of the general type that will be used by the company is desirable. Mr. Ares recommends that an advanced degree in numerical mathematics and several years experience in the use of high-speed computing machinery be required for supervisory personnel. Mr. Pendery concurred with Mr. Ares by advocating sound training in fundamentals of mathematics coupled with a background in engineering, physics, or chemistry, and an intense interest in the computers themselves.

All the panel members agreed that the engineering group can usually furnish more qualified individuals than can the operating levels.

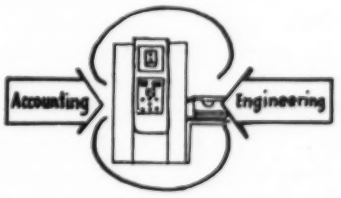
In line with this discussion, it was pointed out that trained computer men are hard to find and employ because there is an actual shortage of them in

El Paso's Kenneth Ares believes that supervisory personnel should be enlisted from the ranks of those trained in the programming and operation of digital computers.

many sections of the country. This would be particularly true of the West Coast and the Southwest. Then, too, recent graduates of engineering schools know very little about this field unless they have had the courses now being offered by some colleges that are designed to teach the techniques of electronic machine computations. Mr. Pendery said: "It is encouraging that all kinds of people have entered the computing field in the past few years, and few have left it for lack of interest or ability."

As previously stated, the computer manufacturers have set up many schools for training those who desire to learn computer programming and operation. Mr. Ares said that engineers who have been selected to program a computer should spend two weeks or so at one of these schools; however, manufacturers have cautioned that these schools are accelerated courses that take the long-range approach. They cover the fundamentals of high-speed computing and programming in general but they do not show the participants how to specifically program gas or pipeline design engineering problems. In fact, the intense interest in computers shown by the military and the aircraft industry has had its effect on the schools. Still, the basic factors to be learned are there and as long as the individual has the ability and an open mind, he can learn the basic concepts and qualify himself for computer work in the gas industry.

Q. Should digital computers be centralized in one department, or is it recommended that accounting department machines be used on a part-time basis for engineering department applications? Or would the volume and nature of the work in engineering applications indicate the need for a separate computer for the engineering department?



Mr. Clennon believes that the computer(s) should be centralized in one department so that optimum use can be made of it, with a high load factor. He said that an accounting department can justify a digital computer more readily than can an engineering department. In this setup, the engineering problems would be solved during "down time," but it is possible that accounting department solutions would yield by-product data and/or statistics that could be advantageously utilized in the operation of a distribution company.

Mr. Clennon feels that it is unrealistic to expect engineering applications alone to produce the volume of work required to justify the installation of an engineering department computer. However, if study establishes that the engineering department does merit its own computer installation, it should be under the supervision of a section head whose sole duty is its operation. He made the point that it would be essential to utilize the section head's skills on a full-time basis by having a constant flow of problems from the other sections within the department.

Robert Moore, who represents a distribution company (as does John Clennon), believes that if the engineering department can use a computer full time, it should have its own, as should any other department with adequate volume of work readily applicable to this equipment; however, he further qualifies his opinion by recommending that the engineering department should not be relieved of the task of developing applications and programs for other departments, because, in his words, "computer utilization is an engineering problem."

Mr. Moore feels that the computers now used in the billing and accounting departments of his company do not lend themselves very well to engineering applications. Some of the general purpose machines are best suited for accounting problems and some are best suited for engineering problems, so he offers the suggestion that as computers are used more and more in the gas industry, the departments will want and need machines more suited to their individual applications.

"The computer doing engineering problems should be under the supervision of an engineer reporting to the manager of the department, with well-developed lines of communications to the staff engineers handling piping design, piping maintenance, building and compressor station design, and cost studies. The policy of job priority should be established by the engineering department manager and applied by the engineer in charge of the computer," was the way Mr. Moore expressed it.

Mr. Naeher said that there will be more efficient utilization of the computer equipment if it is centralized in one service department "where such equipment is available to perform the required operations for all departments." He emphasized that the practicality of using accounting department computers to develop engineering applications and demonstrate to management the efficiency of solving engineering problems with the digital equipment is particularly advantageous. In fact, he said this practice often results in more advanced equipment being installed in the accounting department to the advantage of both departments.

Mr. Naeher, a pipeliner, doubts that an engineering department would have the necessary continuing applications to justify the installation of this type of computing gear for its exclusive use. "Generally, the engineering problems are of such a nature that they either (1) may be scheduled into the monthly flow of work, or (2) occur at such infrequent intervals that the calculations of such problems may be absorbed at off-peak intervals," he said.

"Furthermore, in most gas transmission companies, a very large percentage of the accounting is performed mechanically. A separate department is set up to be responsible for such work and is staffed by experienced personnel. Generally, such equipment includes a computer of one type or another, and because this is the case, I believe that supervision over all computing can be best handled by the supervisor of that department."

Mr. Ares, another pipeliner, acknowledged that the particular setup or organization of a company might warrant either conclusion being reached; however, he brought out several factors that management should carefully consider before making the centralized vs. decentralized decision.

In his opinion, "The machine which can best perform engineering calculations is basically dissimilar to the machine which can most effectively do accounting work. The engineering calculator is required to take a fairly small amount of input data, perform a lot of calculation, and deliver only a few results. On the other hand, the accounting

machine must handle a great mass of input data, do relatively little calculation, and display a great number of results.

"The personnel requirements for machine accounting work, as opposed to engineering type calculations, are quite different. The accounting setup requires a large number of people concerned with data preparation and machine operation with only a few programmers, while the engineering work requires relatively few people preparing data and operating machinery but several programmers."

Mr. Ares did point out that he agrees with the others in regard to the advantage produced by dual use of the machine based on the periodic nature of the accounting work. He recommends, however, that if the objective is to "sell" management on the electronic computers, it would be better to program a typical problem on several of the moderately priced engineering type computers. He believes that "The computation of an engineering problem on a machine specifically designed for that use shows the application of computers in a much more favorable light (and) the computer manufacturers, as a rule, are happy to provide instruction and computer time in order to demonstrate their machinery."

Mr. Ares said that an engineering department can justify its own computer section if there are as many as 20 junior engineers or technical clerks doing engineering-type problem calculation on a routine basis. He points out that an engineering department with its own digital computer (if justified) frees itself from "the mercy of the accounting scheduling, which, in most cases, has the higher priority." This computer section head stressed the need for the computer group to be closely integrated in the engineering organization. He feels that the computer section should serve as a computational aid to the various engineering functions; in this way, the engineers will have more time for creative thinking and less laborious, routine calculating. However, the engineer should retain the responsibility for the basic design concept.

Don Pendery, representative of a major manufacturer of computers, brings up the thought that there actually have been many successful examples of centralized and decentralized computing, and that the answer should be based on a consideration of:

(1) Volume and type of engineering computations.

(2) Volume and type of accounting computations.

(3) Distances between data sources, programmers, engineers, and the centralized computers.

(4) The type of computer or computers used.

"In general, the bigger the computer, the smaller the per-unit cost of calculation," Mr. Pendery said. Centralization may permit the operation of one large machine in place of two small ones. "Distance at one time presented a barrier to centralization, but now, with equipment available for automatically transmitting and receiving punch card data, many companies are either operating or planning to operate large electronic computers from hundreds of miles away."

On the other hand, "scheduling considerations may oppose centralization. Some types of *on-the-line* problems cannot wait. Then, too, the specifications of the computer itself may control the decision. Naturally, engineering would prefer to have its own computing unit, and so would accounting. Some machines are not well suited to both functions."*

Mr. Pendery continued, "Physically, the computer should be as close as possible to the people who will use it. The supervisor of the installation must make certain that engineers with problems can obtain the use of the machine with a minimum of red tape—preferably none. The supervisor usually makes certain that the people who use the machine are properly instructed and that they use it efficiently. It is possible for an untrained person to waste many hours of valuable machine time. The supervisor keeps the computer schedule, assigning time according to an established priority system. Sometimes he has a group of programmers working for him who assist the engineers, or in some cases they may do all of the programming. Supervisors are responsible for the efficiency with which their computer is used. They, therefore, keep accurate records of who used the machine, what the problem was, how long the machine was in use, when and why it failed, etc. If a supervisor does a good job on all of the above, I doubt that it matters who he is or from what department he may come."

*(Note how many times this thought was presented by the panel members.—Ed.)

Q. How do you schedule engineering problems on computers either solely or partially assigned to engineering use?

Generally, the panel was of the opinion that the engineering problems are scheduled on a first-come-first-served basis. Machine time may be broken down into blocks of from 10 to 30 minutes and assigned as requested whenever possible. The chief engineer or chief design engineer may often give a high priority rating to special problems or allow longer time periods for problems taking several hours of computer time. The known distribution engineering problems solved to date were scheduled for a time when the equipment was not engaged in accounting department work.

Mr. Naeher reported a definite schedule for engineering work as follows:

(1) Gas volume calculations . . . . Twice daily (one batch a.m.) (one batch p.m.)

(2) Flow and pack . . . . . Daily (8:30 to 10 a.m.)

(3) In-place reserves . . . . . On request

(4) Line balance . . . . . Monthly (after close of gas volume billing)

Mr. Ares pointed up the fact that although the company has not had too many scheduling problems as yet, it is in the process of developing many new applications and that scheduling will become more acute as the 100% load factor for the computing equipment is approached or reached.

SoCal's Bob Moore feels that the computers now used in the billing and accounting departments of his company do not lend themselves very well to engineering applications.

Q. How many hours do you spend in programming in terms of total computer time?

Mr. Clennon said that to state a definite ratio between programming and computer time might be misleading as there are problems that involve the programming of relatively few mathematical operations, while a non-repetitive, special problem might require 300 to 500 man-hours of programming for each hour of machine time.

Ken Ares said his best guess would be a ratio of 1.25 (for programming) to 1, but qualified it by stating that "the programming includes (1) time spent discussing the nature of the problem with various engineers, (2) investigation of the numerical methods relative to the given problem, (3) curve-fitting of experimental data to obtain functional relationships, (4) basic programming, (5) de-bugging the program, and (6) the write-up of the computational procedure."

Perhaps Don Pendery best summed up the general feeling of the panel as follows: "Many human tasks must precede the solution of an engineering problem on a computer. The problem is analyzed numerically, programmed, program tested, reprogrammed and retested perhaps several times before it is ready for final running. This process of getting ready may take a day for easy problems or it can take several months for complex problems. Fortunately, however, this preparation needs to be done only once for each kind of problem. The running time of problems that recur frequently can be very great over a period of several years. For instance, programming the solution of linear algebraic equations associated with readings from a mass spectrometer might take a week or more before the problem could be solved. Each solution (after the program had been evolved and written) might require less than a minute, but over a year the computer might be asked to furnish many thousands of solutions."

According to Mr. Pendery's experience, the largest computers, which are not being used in the gas industry, may need a staff of from 30 to 50 programmers to keep them operating at 100% load factor, while the medium-sized machine can usually be efficiently utilized by the work of from 5 to 20 programmers. The day may well come when even the largest computers known today are too small for the needs of some of the integrated gas companies, as more and more applications develop from the exploration, drilling, production, processing, transmission, distribution, and utilization phases.

Q. What is the estimated cost of computer programming, and what recommendations can be made to reduce the cost of programming gas engineering problems?

It seems that for general engineering computing, a 50-50 split between the cost of the programs and the cost of the computer will not be too far off for estimating purposes. One company, in gas transmission, has estimated its programming costs to be about 30% of the lease price of their digital computing equipment. Obviously, the programming costs will vary directly with the variation in the type of computation performed.

Some machines are easier to program than others; this may be—but is not necessarily—because of the built-in programming aids found in some of the types of equipment. Also, some computers are equipped with devices that enable them to be switched from one problem type to another without too much re-programming during switch-over or switch-back. These tend to reduce the over-all programming time.

Some machines are being developed to minimize the cost of programming by the improvement of basic design features; in fact, systems are being developed in which the computer will write part or all of the program itself when the programmer feeds the input with an algebraic formula. It is reported that these machines then scan the formula and write the program automatically.

Several of the members of the *GAS* digital, electronic computer symposium panel expressed their belief that a free exchange of information between people using computers, particularly between those using the same basic type of computers, will greatly aid in lowering the cost of programming.

Reports from various manufacturers indicate that much research and experimentation is being poured into efforts to simplify programming, develop programming aids, and lower programming costs. However, the first essential to the solution of any problem (and this is a characteristics of any engineering problem done with or without digital computers) is a clear understanding of what the problem involves physically and mathematically, and how to best proceed toward the solution; so until programming aids are developed or machines are designed to do this there will always be the need for skillful, trained computer engineers to make the careful mathematical analysis for gas engineering problems. ■

According to Mr. Pendery of IBM, the bigger the computer, the smaller the per-unit cost of calculation.

"It is evident from the data presented that New England gas companies generally are in a position to set a ceiling on the cost of gas, and this ceiling is around the present level for natural gas. Unfortunately, however, this fact will not assure New England getting natural gas at this ceiling. This is because gas companies outside of New England are buying natural gas at prices substantially below what it would cost them to produce gas, and are also selling gas at prices materially below competitive price levels. Furthermore, these other utilities are seeking larger volumes of gas. Hence, while the New England companies are in a position to place a ceiling on their cost of gas, they are not in a position to dictate the kind of gas they will distribute. This predicament, if it can be called such, raises the question of what our attitude should be with respect to FPC regulation of producers."

Hall M. Henry

Is New England headed back toward maufactured gas?

By HALL M. HENRY, Vice President • NEGEA Service Corp., Cambridge, Mass.

The recent increase in the price of natural gas attributable to the rise in the field price has caused many of us here in New England to wonder whether we should consider producing all or at least more gas than we now are doing. Were we only faced with the recent increase of 2.15 cents per Mcf, perhaps we should not be considering a return to making gas. Unfortunately, however, this recent price change, affecting as it did the commodity charge, has opened up another potential increase in gas costs. This is because some companies have found that at the 32.15-cent commodity charge, substantial volumes of interruptible loads may no longer be obtainable. This in turn means we may not be able to develop the load factor, which was used in determining the current rate structure, and this, coupled with a slower gas development than expected, could result in another rate adjustment.

Confronted with such a situation, it seems appropriate to review our present position to see what we can do to minimize, if not offset, such increases as may occur. In addition to the price problem, we are also facing a problem brought about by certain financial interests, who believe our present and future economy is related solely to natural gas. Hence, we should also take a look at the future position of our industry.

First, let us see what is our present situation with respect to the costs of producing gas, and thus see whether our current economic position may or can be unduly affected by natural gas prices.

THERE are a number of commercially proven processes which we can use to produce a substitute for natural gas. Furthermore, the gas compositions can be controlled so as to make the gas 100% substitutable for natural gas. The following processes are now available to the gas industry for the production of high-Btu gases suitable for a partial or complete substitution of natural gas. Some of these processes have been available for a number of years, while others are of more recent origin, being the product of the activities of American Gas Association gas production research and the manufacturers.

A. Thermal cracking:

1. *100% oil—heavy or other*
   (a) Pacific coast process

This article has been adapted from a talk presented before the NEGA operating division, Jan. 18, 1955.

(b) Refractory screen
(c) Jones process
(d) Twin generator (with back blast)
(e) Reverse flow
(f) Hall process
(1) Four shell
(2) Three shell
(3 Two shell
(g) Broad ovens

2. *No. 2 oil*
(a) Single generator
(b) Twin generator
3. *Solid fuel for heating—No. 2 or No. 6 for make*
(a) Solid fuel process

B. Partial oxidation
1. *Dayton-Faber process*

C. *Catalytic cracking*
1. Surface combustion
2. C. C. thermofor

D. *L. P. gas-air*
1. Propane-air
2. Butane-air

Of the above processes, we here in New England are primarily interested in:

(f) Hall regenerative process
(c) Catalytic cracking
(d) L. P. gas-air

There could be certain instances where twin generators or single generators could be used to advantage for at least a portion of a gas company's loads.

Established procedures

It is well to point out that of these processes the Hall, L. P. gas-air and twin and single generators have been used by enough gas companies over a long period (in some cases, five years or more), to have fully established the operating results from which an economic appraisel can be made. For instance, the data, which will be shown later to illustrate what might be expected should a gas company decide to produce gas rather than buy natural gas, were obtained from two different gas companies, both of whom had operated Hall high-Btu oil gas sets for several years and both of whom had produced about the *same* annual volumes. Thus, we have a good check on the various production cost components. The catalytic processes have been operated using propane, butane, gasoline and No. 1 oil. The Surface Combustion TPC has been developed to the pilot plant stage and certain operating data are available for an evaluation of this process.

> *"It is evident that New England distribution companies have a real interest in the outcome of regulation of producers. It would appear that if favored nation clauses could be removed from existing and future supply contracts, field prices of gas going to new transmission lines would not affect the price of transmission companies already in business, and regulation of producers would not seem at all necessary or desirable. It does seem that until undesirable escalation clauses now in existence are corrected, we here in New England may have to be, however reluctant, for regulation of producers."*

High Btu oil gas may compete

A study of the 12-month operating results in 1953 of a company (we will call Co. A) producing high-Btu oil gas using Regular No. 6 oil shows the holder cost of gas (1000 Btu/cu ft) was *68.1 cents*/Mcf. For this same company, the cost of natural gas plus standby and peak shaving for the 12 months ending November 1954 was 64 cents. This latter figure was based on a sendout of 1,981,798 Mcf vs. a sendout of 1,655,640 Mcf when the company was producing gas. If the manufactured oil gas cost figures are adjusted to reflect what these costs would be when producing 2000 MMcf instead of 1,655,640 Mcf, the holder cost becomes 65.1 cents. Bear in mind the figures given were taken directly from the company's operating statement.

When we analyze the recorded results, we find, first, all of the tar produced was not sold in the year produced; furthermore, the company had considerable trouble with its light oil scrubber (now corrected) so full recovery of light oil was not possible; the waste heat boiler was only operated for one month of the 12; and, finally, a new method of tar dehydration would substantially reduce dehydration costs. Now, if these adjustments are made to the recorded results, and making allowances for the oil price that would have prevailed during the past 12 months, we find that gas might have been produced for 56.47 cents/Mcf vs. 64 cents for natural gas plus standby and peak shaving loads, or a saving of some 7.53 cents/Mcf in favor of manufactured gas.

Table 1 shows the comparative gas production cost figures for the two different companies, one (Co. A) using regular No. 6, the other (Co. B) using a premium residual oil most of year with some No. 6. Figures are for 12 months ending Aug. 30, 1953, the last full year on gas production.

Table 2 shows the various adjustments that should be made to the recorded costs, to reflect the known reductions or increases in costs because of the tar, light oil, waste heat boiler steam and tar dehydration factors previously mentioned plus changes in oil prices.

The figures in *Table 2* clearly show that where a company already has in being facilities similar to those at Co.'s A and B, capable of using No. 6 oil, and fuel and residual credits are of the value shown, the cost of producing gas may be less costly than buying natural gas.

Factors to be considered

Many factors must be analyzed and evaluated in considering whether to manufacture gas or buy natural gas. For instance, where it is necessary to convert existing equipment or install additional facilities to produce gas, then to

In two installments

Matters of future gas supplies, including gas from crude shale oil, oil shale, the process of making gasoline from coal, synthesis gas from coal, and pipeline gas from coal will be discussed in next month's installment.

	Company A	Company B
MCF Produced (1000 Btu/cu. ft.)	1,655,640	1,640,124
Unit Prices:		
Oil/Gal.	$0.0503	$0.0605
Tar/Gal. (Net)	$0.0650	$0.0670
Light Oil/Gal.	$0.1500	$0.1490
Materials Used/MCF		
Gen.	1.00 gals.	.72 gals.
Make	14.15 "	13.30 "
Total	15.15	14.02 "
Residuals:		
Tar	4.15 gals.	4.19
Light Oil	0.65 "	0.708
Steam	-	-

	Co. A	Co. B
Costs Gas Produced/MCF:		
(A) F.O.T.S.L. Costs:		
(1) Raw Materials:		
Oil Heat	$0.055	$0.039
Oil Make	0.710	0.811
Sub total	$0.765	$0.850
Steam and Power	$0.069	$0.105
Water	0.002	0.004
Sub total	$0.071	$0.109
Total	$0.836	$0.959
(2) Residuals Credit:		
Tar	$0.274	$0.272
Light Oil	0.098	0.106
Steam	-	-
Sub total	$0.372	$0.378
F.O.T.S.L. Costs	$0.464	$0.581
(B) Processing Costs:		
Labor	$0.086	$0.080
Purification Supplies	0.024	0.023
Miscellaneous	0.020	0.017
Sub total	$0.130	$0.120
(C) Maintenance:		
Gas Gen. Equipment	$0.039	$0.032
Storage Facilities	0.009	0.002
Other	0.039	0.031
Sub total	$0.087	$0.065
Total Processing and Maintenance	$0.217	$0.185
TOTAL PRODUCTION COST	$0.681	$0.766

Table 1. Comparative gas production costs.

	Co. A	Co. B
Actual Oil Price (12 mos. Aug. 1953)/gal.	$0.0503	$0.0605
Average-1954 Oil Price/gal.	0.0525	0.0565
Difference	$0.0018	($0.0040)
Actual Holder Cost	$0.681	$0.766

Adjustments:	Co. A	Co. B
(A) 1954 Oil Price	($0.0237)	$0.056
(B) Tar Produced (not sold year produced)	0.0325	0.020
(C) Light Oil Lost (Faulty Equipment)	0.0225	0.015
(D) Waste Heat Boiler Not Used	0.0250	0.035
(E) Tar Dehydration (New Process)	0.0300	0.030
Total Adjustments	$0.0867	$0.156
ADJUSTED HOLDER COST	$0.5947	$0.6100
Adjustment for Increased Make	0.0300	0.0300
Probable - Today Costs	0.5647	0.5800
Actual 12 Mos. - Natural Gas	0.6400	0.6596

Table 2. Adjustments to recorded gas-making costs.

	Co. A		Co. B	
	New*	Total	New*	Total
Production Inv.	$568,956	$2,630,615	$707,461	$2,552,000
Fixed charges @ 16%	94,033	420,896	113,193	408,320
Per MCF	$0.0475	$0.2124	$0.0572	$0.2065
Holder cost (adj.)	$0.5647	$0.5647	$0.5800	$0.5800
Total	$0.6122	$0.7771	$0.6370	$0.7865

*New:
The Production Investment shown covers that which was spent to equip the plant to produce high Btu gas using heavy oil.

Table 3. Fixed charges on production facilities.

Size of Plant	Number of Operating Units	Approx. Cost in Dollars per MCF of Daily cap.
5 000 MCF	Two - - - 12'-0" Units (one for spare)	$262.
10 000 "	Three - - - 12'-0" " " " "	$202.
15 000 "	Three - - - 13'-0" " " " "	$182.
20 000 "	Four - - - 13'-0" " " " "	$170.

Table 4. Cost of complete high-btu oil gas plants.

Some competitive cost analyses for gas production

INVESTMENTS: Per MM BTU/Day Capacity

Size Plant MCF/day (1,000 Btu/cu. ft. gas)	1500	2500	5000	10,000	12,000	15,000
Plant*	$25.70	$16.10	$12.00	$10.70	$10.00	$ 9.70
Storage**	110.00	110.00	110.00	110.00	110.00	110.00
Total	$135.70	$126.10	$122.00	$120.70	$120.00	$119.70

* All equipment including boilers. No land.
** Basis of 20 day supply L. P. gas.

PROCESSING COSTS:	1500	2500	5000	10,000	12,000	15,000
Labor per MM BTU	$0.005	$0.005	$0.005	$0.005	$0.005	$0.005
Maintenance per" "	0.005	0.005	0.005	0.005	0.005	0.005
Other - Steam, etc.	0.010	0.010	0.010	0.010	0.010	0.010
Total	$0.020	$0.020	$0.020	$0.020	$0.020	$0.020

FUEL COSTS:					
Unit Prices/Gal.	5¢	6¢	8¢	10¢	12¢
Cost/MM BTU	$0.55	$0.66	$0.88	$1.10	$1.32

TOTAL COSTS - TWO PLANT SIZES:					
1,500 MCF/DAY CAP.	5¢	6¢	8¢	10¢	12¢
Fuel Costs	$0.550	$0.660	$0.880	$1.100	$1.320
Fixed Charges @ 20% (90% Load Factor)	0.082	0.082	0.082	0.082	0.082
Processing Costs	0.020	0.020	0.020	0.020	0.020
Total Costs	$0.652	$0.762	$0.982	$1.202	$1.422
15,000 MCF/DAY CAP.	5¢	6¢	8¢	10¢	12¢
Fuel Costs	$0.550	$0.660	$0.880	$1.100	$1.320
Fixed Charges @ 20% (90% Load Factor)	0.072	0.073	0.073	0.073	0.073
Processing Costs	0.020	0.020	0.020	0.020	0.020
Total Costs	$0.643	$0.753	$0.973	$1.193	$1.413

Table 5. Economics of L. P. gas-air production, with storage in metal containers.

INVESTMENTS: PER MMBTU/DAY CAPACITY

Size Plant MCF/Day (1,000 BTU/cu. ft. gas)	5,000	10,000	12,000	15,000
Plant*	$12.00	$10.70	$10.00	$ 9.70
Storage**	11.00	11.00	11.00	11.00
Total	$23.00	$21.70	$21.00	$20.70

* All equipment including boilers. No land.
** Basis 20 day supply. (Cavern storage cost data basis of 1,000,000 gal.)

PROCESSING COSTS:				
Labor	$0.005	$0.005	$0.005	$0.005
Maintenance	0.005	0.005	0.005	0.005
Other - Steam, etc.	0.010	0.010	0.010	0.010
Total	$0.020	$0.020	$0.020	$0.020

FUEL COSTS:					
Unit Prices/gal.	5¢	6¢	8¢	10¢	12¢
Cost/MMBTU	$0.55	$0.66	$0.88	$1.10	$1.32

TOTAL COSTS - TWO PLANT SIZES:					
5,000 MCF/DAY CAPACITY	5¢	6¢	8¢	10¢	12¢
Fuel Costs	$0.550	$0.660	$0.880	$1.100	$1.320
Fixed Charges @ 20% (90% Load Factor)	0.014	0.014	0.014	0.014	0.014
Processing Costs	0.020	0.020	0.020	0.020	0.020
Total	$0.584	$0.694	$0.914	$1.134	$1.354
15,000 MCF/DAY CAPACITY	5¢	6¢	8¢	10¢	12¢
Fuel Costs	$0.550	$0.660	$0.880	$1.100	$1.320
Fixed Charges @ 20%	0.013	0.013	0.013	0.013	0.013
Processing Costs	0.020	0.020	0.020	0.020	0.020
Total	$0.583	$0.693	$0.913	$1.133	$1.353

Note: The importance of cavern storage is clearly shown by comparing the investment cost above for 10,000 MM BTU/day plant with cost shown for metal storage. These are $21.70 for cavern vs $120.70 for metal.

Table 6. Economics of L. P. gas-air production, with cavern storage.

the holder costs previously shown must be added the carrying charges on the investment. However, this may be affected by company policy in regard to standby. Thus the economics of making gas vs. purchasing natural gas will depend on the following factors:

(1) Price of natural gas
(2) Cost of oil and steam
(3) Value of residuals
(4) The processing costs
(5) The fixed charges
(6) Company policies

Company policy, with respect to whether it requires production facilities for 100% standby in case of failure of natural gas, could be the deciding factor as to whether it is best to produce gas or buy natural gas. If the policy is to have 100% standby and if the company has selected its equipment on the basis of the economics of producing 100% of its gas requirement for, say, a 10-day period, it may have equipment of the type in use by Co. A and Co. B; hence, there would not be any fixed charges to assess against the cost of producing gas. On the other hand, where a company must add to its production plant investment in order to manufacture its entire gas requirements or to be able to use heavy oil, the fixed charges on this added investment may be the deciding factor between making gas and buying it.

Probable impact

The probable impact of this factor on the cost of producing gas is shown by taking the fixed charges on production facilities for Cos. A and B (see *Table 3*). The fixed charges on the total production plant is shown as well as the added fixed charges resulting from equipping the plant to produce a high-Btu gas from heavy oil.

From *Table 3* we see that if Co. A did not have the equipment represented by the production investment of $568,956 shown under "new" in the table, it would have to consider its costs to produce gas as being $0.6122 instead of the $0.5647 figure, and Co. B would have to consider $0.6370 instead of $0.5800.

The impact of the fixed charges on the cost of producing gas will vary with each company, but the above will illustrate the probable magnitude of this factor—5 cents to 6 cents per Mcf where a company now has production facilities and is faced only with converting its present facilities. If the fixed charges on the *total production* plant investment are to be considered, then 20 cents to 22 cents per Mcf must be added to the holder cost, bringing the cost of gas to $0.7771 for Co. A and $0.7865 for Co. B.

Cost of complete high-Btu oil gas plants

The preceding investment cost figures were for companies that already had production facilities. This situation would be somewhat different where no production facilities now exist. The cost figures shown in *Table 4* for new complete high-Btu oil gas plants have recently been supplied by one large manufacturer of gas production equipment. These figures, while not specific for any given situation, are indicative of what it might cost for a new high-Btu oil-gas plant. The costs are "for a complete plant erected excluding storage holder, but including relief holder, buildings, operating units and all auxiliaries such as washer coolers, electric precipitators, oil scrubbers, light oil recovery equipment, exhausters, purifiers, all pipelines, tar handling, etc."

These figures are interesting, as they indicate that the costs for a complete new plant are not materially different from the present book costs per Mcf of existing plants for some companies: For instance, cost per Mcf of effective capacity: Co. A, $196; Co. B, $223.

Anyone interested in building a new plant should keep in touch with the work now being carried on at IGT in connection with high-pressure gasification of heavy oil. It is possible that because it produces the gas under pressure, the auxiliary equipment sizes will be substantially reduced and could result in a lower total plant investment cost.

Another angle that should be considered is the use of hydrogen during the gas-making cycle. Preliminary studies have indicated that set capacities might be increased as much as 50% by the use of hydrogen, and this may also be a factor in lowering the investment costs. Furthermore, the use of hydrogen will yield a gas that is 100% interchangeable with natural gas.

While in general throughout the New England states, the Hall regenerative process or the TPC process (as will be outlined later) will be found to be the most economical, there are situations where L. P. gas might prove to be cheaper, all factors considered. There are several recent developments that might be of interest in connection with the consideration of L. P. gas.

One of these new developments has to do with the storage of L. P. gas, which is one of the more costly elements, particularly in connection with peak shaving. The cost of storage may be reduced over that of conventional tanks by the use of pipe storage or by underground storage or refrigeration storage. The cost of underground storage may run as low as 2 cents to 5 cents per gallon vs. 60 cents to $1 for conventional storage, and plant investments for L. P. gas-air units may run $10 to $30/Mcf/day of 1000-Btu gas depending on the size. *Tables 5* and *6* show the probable costs of producing gas at various unit prices for L. P. gas.

It may seem strange to New England company managers that we show figures for L. P. gas costs of 5 cents to 6 cents/gal. The reason is that the cost of transporting L. P. gas to New England can be substantially reduced by one method already in operation (not in New England) and hence proven, and by another method which has the potentialities of lowering transportation costs, so as to make it possible to deliver L. P. gas at cost figures as low as the 4 cents/gal. figure. Certainly, if natural gas prices are going to continue to rise this matter should and will be more actively pursued.

High pressure hydrogasification of oil

A high-pressure hydrogasification unit developed by IGT under funds advanced largely by East Ohio Gas Co., can use butane, propane, low-grade gasoline, and kerosene to produce gas. The investment costs are reportedly low—only $100 per Mcf—and this could be brought down to $60 if CO_2 scrubbing is eliminated. (This latter can be eliminated.) The operating costs are largely a function of the cost of raw material since only one man per shift is required to operate. The projected costs for cer-

tain assumed fuel prices are given in *Table 7*.

With propane or butane at 5 cents/gal. (which, as pointed out previously, is not an impossibility), the total cost for gas made in a pressure hydrogasification unit will be 55 cents to 70 cents per Mcf, depending on the type of investment and days per year plant is operated.

Costs of natural gas plus standby and peak shaving costs are running as high as $1.05 for some of the smaller gas companies. The potentialities of this pressure hydrogasification unit should be thoroughly explored. Not only might such a unit prove to be economical for small gas companies but because of the low fixed charges and low labor costs, the pressure hydrogasification unit might also prove economical for peak shaving and standby.

Thermofor pyrolytic cracking

Gasification of residual oils has been carried out in a pilot scale plant built and operated by the Surface Combustion Corp. In a report on the status of their TPC process, given before the AGA operating section chemical, engineering and manufacturing gas production conference in May 1954,* T. F. Loughry of Surface Combustion pointed out the economics of the TPC process, explaining that "the final market analysis to determine actual values of the by-products have not yet been completed."

The AGA operations research committee has been watching the developments of this process, and has spent some money in testing the unit and in having an economic appraisal made of the byproducts. A report has been received on the potential market value of the byproducts, and we now can make an economic evaluation in light of this additional information. *Tables 8* and *9* show the potential costs of producing gas using the TPC process vs. the Hall process. It will be noted that the table contains the original cost data prepared by Mr. Loughry, and an adjusted column reflecting the following:

1. New residual credit price for coke.
2. Labor, steam and costs incidental to purification, cleaning, light oil recovery, etc., not included in Mr. Loughry's figures.

A study of the actual and adjusted production cost figures (*Tables 10A* and *10B*) of the TPC and Hall process shows there is some economic advantage in the TPC process at 300 days use. At 140 days use the Hall process would provide a lower over-all cost (see *Table 11*).

There are two indicated advantages the TPC process has over Hall. The gas from the TPC is more interchangeable, and it is expected to be able to process heavier bunker "C" oil than the Hall. These advantages may disappear with the use of hydrogen during the cracking of oil in the Hall process. The AGA is now doing some research in this, but it will be several months before we can fully evaluate the use of hydrogen.

The data thus far presented clearly show that our present gas production techniques are economically sound; at current prevailing fuel and residual prices, gas may be produced for a cost comparable with natural gas in New England, and under certain circumstances might prove to be less costly, when standby and peak shaving costs are added to the cost of natural gas. This is quite encouraging to us here since we can thus establish a ceiling on the cost of gas.

Price ceiling

It is evident from the data presented that New England gas companies generally are in a position to set a ceiling on the *cost of gas*, and this ceiling is around the present level for natural gas. Unfortunately, however, this fact will not assure New England getting *natural gas* at this ceiling price. This is because gas companies outside of New England are buying natural gas at prices substantially below what it would cost *them* to produce gas, and are also selling gas at prices materially below competitive price levels (see *Table 12*). Furthermore, these other utilities are seeking larger volumes of gas. Hence, while the New England companies are in a position to place a ceiling on their *cost of gas*, they are not in a position to dictate the *kind of gas* they will distribute. This predicament, if it can be called such, raises the question of what our attitude should be with respect to FPC regulation of producers.

Factors that should be considered in connection with this problem, and how New England gas interests and consumers may be affected by regulation are presented in the box on page 56.

It is evident that New England distributing companies have a real interest in the outcome of regulation of producers. It would appear that if *favored nation clauses could be removed from existing and future supply contracts*, field prices of gas going to new transmission lines would not affect the price of transmission companies *already in business*, and regulation of producers would not

COMING - next month

April GAS will be the annual Distribution Issue, with emphasis on maintenance of equipment used by distributing gas utilities. For example . . .

How one major utility handles its distribution system maintenance program . . .

Maintenance of a coke-oven gas plant, treated from the standpoint of check points . . .

Maintenance of a standby-peak shave plant, where the long periods of idleness have given rise to new upkeep problems and shifted the emphasis in work policies from production to maintenance . . .

Maintenance in a mobile radio establishment, where through careful scheduling on a preventive basis, outages have been held to a tolerable minimum . . .

And in the Pipeline Section, the first report on how a full-opening gate valve may be used as a field measuring device, including data on the determination of discharge coefficients, proper location of the pressure tap, etc.

. . . and a half-dozen other top-interest feature articles, exclusively in GAS for April.

*See also "A Thermal Cracking Process for Producing High-Btu Gases" by Mr. Loughry in *GAS*, November 1953, p. 27.

PRESSURE HYDROGASIFICATION OF LIGHT DISTILLATES:

	Propane	Butane	26 lb. nat. gasoline	No. 1 Fuel Oil
PER MCF				
Fuel for Hydrogen prod.	1.2	1.0	1.0	1.0
Make Fuel	9.5	8.3	7.7	6.2
Heat Fuel				2.1
Total	10.7	9.3	8.7	9.3
Total Steam Lbs.	49	57	73	107

UNIT FUEL PRICES:

Fuel	5¢	12¢	5¢	12¢	12¢	11¢
Steam	75¢	75¢/M lbs.	75¢	75¢	75¢	75¢

HOLDER COSTS:

Fuel	$0.535	$1.284	$0.465	$1.116	$1.044	$1.023
Steam	0.037	0.037	0.043	0.043	0.055	0.080
Labor	0.010	0.010	0.010	0.010	0.010	0.010
Maint.	-	-	-	-	-	-
Total	$0.582	$1.331	$0.518	$1.169	$1.109	$1.113

	$100 Inv./MCF		$60 Inv./MCF	
Use per Year	140 Days	300 Days	140 Days	300 Days
Fixed Charges @ 16%	$0.114	$0.0533	$0.073	$0.032

TOTAL COSTS INCLUDING FIXED CHARGES

	$100 Inv.		$60. Inv.	
Day Use/Year	140 Days	300 Days	140 Days	300 Days
Propane @ 5¢/gal.	$0.696	$0.4530	$0.655	$0.614
Butane @ 5¢/gal.	$0.632	$0.5713	$0.591	$0.550
Propane @ 12¢/gal.	$1.445	$1.386	$1.404	$1.363
Butane @ 12¢/gal.	$1.283	$1.213	$1.243	$1.201
26 lb. gasoline 12¢/gal.	$1.223	$1.162	$1.182	$1.141
No. 1 Fuel Oil 11¢/gal.	$1.227	$1.166	$1.186	$1.145

Table 7. Costs per Mcf.

Day Use of Plant	T. P. C. 300 S. C.[1]	T. P. C. 300 Adj.[1]	HALL PROCESS 123 Actual	HALL PROCESS 140 Adj.	HALL PROCESS 300 Est.
Investmen. Costs/MCF					
Generating Equipment-only	$137 50	$137 50			$ 40
All Other	None	140 00			160
Total Complete Plant	$137 50	$277 50			$ 200
Operating Results:					
BTU/cu. ft.	1 000	Same	1 000	1 000	1 000
Heat Oil Gal/MCF	2.6	"	1.0	1.0	0.85**
Make Oil " "	13.7	"	14.15	14.15	14.15
Total	16.3	16.3	15.15	15.15	15.00
Steam (process) lbs. /MCF	2.5#	Same			
" (other) " "	None	"			
Total	2.5#	2.5#			
Residuals:					
Tar Gals/MCF	4.4	Same	4.150	4.640	4.640
Light Oils Gal/MCF	0.0	"	.657	.807	.807
Sub total	4.4	4.4	4.807	5.447	5.447
Steam	None	25 #s	None	50 #s	
Coke - Lbs.	19.9	19.9	None	None	
Unit Prices:					
Heat Oil	$0.0525	Same	$0.0510*	$0.0525	$0.0525
Make "	0.0525	"	0.05034*	0.0525	0.0525
Tar	10¢	10¢	0.0660	0.0760	0.0760
" Dehydration Allowance	None	$0.0059	0.0159	0.0059	0.0059
Light Oil	-	-	0.150	0.1500	0.1500
Steam	0.75	0.75	0.75	0.75	0.75
Coke	$10.00	$20.00	-	-	-
Power	0.01	0.01	-	-	-

** Actual 3 mo. average January, February, March when operating at rate of 58% L. P. = 211 days/year.
* Heat and Make oil averaged - $.05036 or $2.115/bbl.

(1) The column headed S. C. contain the figures and data taken from Loughry's paper previously referred to. The adj. column represents the adjustments deemed necessary to include all the gas production costs essential to a final processed gas, plus certain additional investments required ie. purifiers, washers, exhausters, controls, etc.

Table 8. TPC and Hall process operating results and investment costs.

	Holder Cost 140 Days Use of Plant Cap.	Holder Cost 300 Days Use of Plant Cap.	Total Cost Including Fixed Charges 140 Total	140 Gen.	300 Total	300 Gen.
Hall	$0.5558	$0.4980	$0.7709	$0.6287	$0.6047	$0.5193
T. P. C.	0.4831	0.4253	0.8001	0.6401	0.5720	0.4948
Hall over T. P. C.	0.0727	$0.0727	($0.0292)	($0.0114)	$0.0327	$0.0245

Table 11 (above). Overall cost comparisons.

Table 12 (right). Comparison of calculated price of gas per thousand Btu and equivalent price per thousand Btu to equal cost of electricity or oil for water heating, cooking, and heating (holder cost and actual cost, domestic sales).

Days Use	T. P. C. 300 S. C.	T. P. C. 300 Adj.	HALL PROCESS 123 Actual	HALL PROCESS 140 Adj.	HALL PROCESS 300 Est.
Material Costs/MCF:					
Make Oil	$0.1365	Same	$0.051	$0.052	$0.045
Heat Oil	0.7193		0.712	0.743	0.743
Total	$0.8558	$0.8558	$0.763	$0.795	$0.788
Credits:					
Tar	$0.4400	$0.4400	$0.274	$0.353	$0.353
Light Oil	-	-	0.098	0.121	0.121
Coke	0.0995	0.1900	-	-	-
Waste Heat Boiler	-	0.0125	-	0.025	0.025
Sub total	$0.5395	$0.6425	$0.372	$0.499	$0.499
Net Material Costs	$0.3163	$0.2133	$0.391	$0.296	$0.289
Other Costs					
Steam, Power, Water	$0.0270	$0.0530	$0.071	$0.0638	$0.053
Labor	0.0070	0.0210	0.086	0.0688	0.043
Purification	-	0.0260	0.024	0.0260	0.024
Tar Dehydration	-	0.0260	Inc. in Tar Price*		
Miscellaneous	-	0.0220	0.022	0.0192	0.015
Sub total	$0.0340	$0.1460	$0.203	$0.1758	$0.135
Maintenance:					
Gas Gen. Equip.	$0.0290	$0.0290	$0.039	$0.039	$0.039
Purification & Light Oil and Misc.	-	0.0250	0.025	0.025	0.025
Production Equipment Storage	-	0.0050	0.009	0.008	0.005
Other	-	0.0070	0.014	0.012	0.007
Sub total	$0.0290	$0.0660	$0.087	$0.084	$0.076
Total Other	$0.0630	$0.2120	$0.290	$0.2598	$0.209
Holder Cost	$0.3790	$0.4253	$0.680	$0.5558	$0.498

*Actual allowed to Tar Company - 1 1/4¢/gal = 5.10¢/MCF
Balance Company expense 1/3¢/gal = 1.36¢/ "
Total 6.46¢/MCF
Company received 8 1/4¢/gal. for tar less 1-1/4¢ + 1/3 or $0.066¢/gal. net

Table 9. Comparative data and costs, TPC vs. Hall process.

Days Operation/Yr.	T. P. C. Est. & Adj. 140	T. P. C. S. C. 300	T. P. C. Adj. 300	HALL PROCESS Actual 123	HALL PROCESS Adj. 140	HALL PROCESS Est. 300
Plant Investment:						
Generating equip.	$137 50	$137 50	$137 50	$ 55 00	$ 55 00	$ 40 00
All Other	140 00	-	140 00	132 00	132 00	160 00
Total	$277 50	$137 50	$277 50	$187 00	$187 00	$200 00*
Fixed Charges:						
at 16%/Yr.	$ 44 30	$ -	$ 44 30	$ 29 92	$ 29 92	$ 32 00
at 13%/Yr.	-	17 88	-	-	-	-
Cost Gas + Fixed Charges						
Per MCF	$0.3170	$0.0596	$0.1467	$0.2562	$0.2151	$0.1067
Holder Cost	0.4831	0.3790	0.4253	0.6800	0.5558	0.4980
Total	$0.8001	$0.4386	$0.5720	$0.9362	$0.7709	$0.6047

*Estimates include spare Generating Equipment.

TABLE 10 (B)

Holder Costs + Fixed Charges on Generating Units Only:

Investment/MCF	$137 50	$137 50	$137 50	$55 00	$55 00	$40 00
Fixed Charges @16%	22 00	22 00	22 00	8 80	8 80	6 40
Cost Gas + Fixed Charges: per MCF						
Fixed Charges	$0.1570	$0.073	$0.0730	$0.0715	$0.0629	$0.0213
Holder Cost	0.4831	0.379	0.4253	0.6800	0.5558	0.4980
Total	$0.6401	$0.452	$0.4983	$0.7515	$0.6287	$0.5193

Table 10 (A and B). TPC and Hall process comparative holder costs, including fixed charges on production plant investment.

Co. No.	Holder Cost of Gas	Gas vs Elec. Cooking Gas	Gas vs Elec. Cooking Elec.* Equiv.	Gas vs Elec. Water Heating Gas*	Gas vs Elec. Water Heating Elec.* Equiv.	Gas vs Oil Heating Gas*	Gas vs Oil Heating Elec.* Equiv.	Composite for 3 Services Gas	Composite for 3 Services Elec. & Oil Equiv.	Actual Ave. Price Dom. Sales
Cos. Outside NE States										
1	14.38¢	$1.37	$2.69	$0.72	$1.89	$0.38	$1.11	$0.48	$1.31	$0.4686
2	17.82¢	1.92	2.36	0.62	1.32	0.55	0.93	0.63	1.06	0.7018
3	19.40¢	1.80	2.99	0.63	1.89	0.55	1.05	0.63	1.27	0.6790
4	22.80¢	2.18	2.99	1.04	1.39	0.75	1.18	0.87	1.30	0.8670
5	24.30¢	1.37	3.99	0.87	1.81	0.68	1.01	0.74	1.27	0.7698
6	24.54¢	1.12	4.48	0.50	3.79	0.50	1.14	0.53	1.70	0.5985
7	25.00¢	1.90	4.25	0.72	2.27	0.72	1.25	0.77	1.55	0.7600
8	27.00¢	1.80	3.73	1.30	1.61	0.68	1.12	0.83	1.32	0.7800
9	28.63¢	2.24	2.99	0.60	2.08	0.60	1.17	0.68	1.39	0.6225
10	32.00¢	1.50	2.84	1.25	1.51	0.93	1.26	1.00	1.37	1.2380
11	32.78¢	1.49	2.99	0.57	3.41	0.60	1.14	0.64	1.56	0.6490
12	35.10¢	1.88	2.94	1.40	3.16	1.06	1.19	1.15	1.57	1.2080
13	38.50¢	2.19	3.26	1.03	2.03	0.60	1.34	0.74	1.55	1.0200
14	38.87¢	2.87	3.73	1.27	2.88	1.17	1.18	1.27	1.56	1.6400
15	47.20¢	2.01	2.68	1.71	1.89	1.34	1.15	1.43	1.34	1.6900
NE Cos.										
To	68.70¢	4.15	4.48	1.80	1.89		1.22	1.35	1.49	2.0972
17	64.00¢	2.76	3.55	2.22	4.50		1.19	1.48	1.80	1.9480
18		3.27	2.73	2.28	3.92		1.24	1.57	1.75	2.1099

*Gas costs for cooking were calculated using the first steps of each company's, published rates, and the next steps for figuring costs for water heating and the final steps or any special rates for heating.

The electric costs were similarly calculated making due allowance for the lighting and refrigeration load.

The oil costs were calculated using the price for No. 2 oil as reported by each company.

The following units were used in calculating the respective costs for each class of service.

	UNITS PER YEAR		
	Cooking and Water Heating	Heating	Total
Gas-MCF (1000 Btu)	30.8	125	155.8
Oil-Gals.	404.4	1112	1516.4
Electric-Kwhrs.	9520.0	--	--

Manufactured gas . . . "Financial people are tying our well-being to . . . natural gas."

seem at all necessary or desirable. It does seem that until undesirable *escalation clauses* now in existence are corrected, we here in New England may have to be, however reluctant, for regulation of producers.

This seems to be the only position we can take in view of the fact that companies nearer the gas reserves can afford to have their transmission companies pay a higher field price for natural gas than companies supplying New England. Furthermore, it seems that these other companies would be only too happy to take over the natural gas now coming into New England.

Were it not for these facts, we here in New England could dictate the ceiling we can and are willing to pay for natural gas.

Financial people's attitude

Since we are now obtaining most of our gas from the natural gas transmission companies, the financial people are tying our economic well-being to the available supplies of natural gas. This is clearly indicated by the following comment by a vice president of one of the largest life insurance companies in the U. S.:

"The gas distributing companies in the Northeast have tremendously improved their credit standing in the last 10 years. As manufactured gas companies, the distributors in this area were regarded as poor credit risks by the institutional investors. With the introduction of natural gas their position has improved to the point where their bonds are considered prime investments by the large insurance companies. Insurance companies are long-term investors and feel that they must assure the soundness of their utility investments for periods up to 25 or 30 years. In the absence of positive proof to the contrary, the insurance companies believe that *the improved financial condition of gas distribution companies is almost wholly due to the introduction of natural gas.* Consequently, the insurance companies generally require a substantial sinking fund to offset the effect of *depletion of natural gas* supplies available to the distribution companies.

"The insurance companies are aware that local distributing companies have alternative means of producing high-Btu gas, but they are not convinced of the feasibility of wholesale substitution of high-Btu oil gas for pipeline gas at a cost that will maintain the *competitive position of gas in the local marketing area.* As far as insurance companies are concerned, the possibility of high-Btu gas from coal at a competitive *cost level is no more than an interesting possibility.* Insurance companies are willing to reconsider the question of high sinking funds on gas distributing company bonds when the industry has demonstrated from actual plant operation that economic substitutes for natural gas are realities.

"The long-term threat of electric competition is at this stage a minor factor in the insurance company requirement of high sinking funds in gas distributing company bonds."

All of the above, with the exception of the last paragraph, was confirmed by contacts made with vice presidents of other major insurance companies. *At least two of these latter vice presidents believe that the threat of electric competition is also a factor in the insurance companies' attitude.*

It is obvious that insurance companies are requiring these restrictions for the two major reasons, namely, that we (according to the financial viewpoint) are distributing a "wasting asset," and they have come to the conclusion (though highly debatable as will be shown in next month's installment) that our economic well-being will end with the expiration of our natural gas contracts. ■

(To be continued)

Factors to be considered in connection with the problem of regulation

(1) The price of natural gas has undoubtedly been affected by the requirement of the FPC that transmission companies must have 20 years' reserve *in being* at time of certification.

(2) The uncertainty that existed, prior to the Supreme Court's decision in the Phillips' case, as to whether producers were subject to regulation, caused large reserves of natural gas to be (and they still are) withheld from the market.

(3) The competition for reserves by *new* and old transmission companies with the above factors present naturally drove the price of gas upward.

(4) This latter would not have seriously affected gas costs to *existing transmission companies* had there not been favored nation clauses in the supply contracts of these companies.

(5) It is obvious that, with the scramble for reserves, plus the hold-out of large undedicated reserves due to fear of regulation (now a reality), plus the requirement for 20-year reserves *in being* at a time of certification, plus the favored nation clauses in supply contracts, natural gas prices did move upward and would undoubtedly have risen much higher had there been no Supreme Court decision in the Phillips' case.

(6) Unfortunately for New England, the transmission companies supplying gas companies west and southwest from New England can afford to pay higher field gas prices than now exist and still offer a satisfactory gate station price to distribution companies because of the shorter haul of natural gas.

(7) It is, of course, impossible to predict what effect the regulation of producers will have on future natural gas prices and supplies. It is evident, however, that for the present it has been helpful in slowing down the field price movement and regardless of what action Congress may take, there should be a more wholesome regard for the effect field prices have on markets.

(8) It would seem that regulation cannot affect the *supplies "dedicated"* to *existing transmission companies* even though it appears that regulation of producers has at least temporarily put a stop to *projected transmission lines.*

(9) It does not seem possible that the owners of large gas reserves can or will withhold indefinitely these potential supplies from the market.

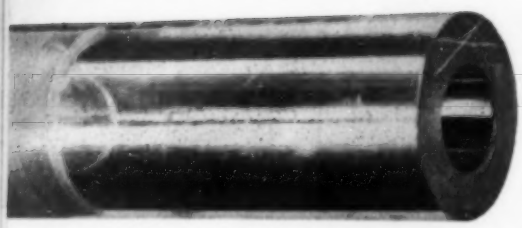
(10) These reserves will, in my opinion, ultimately find their way into the market place by reason of economic pressure or, *if the public interest so requires, by regulation.*

(11) From the data available it does not appear as though the threat of using these undedicated reserves for petrochemicals, or for enticing industries to locate within the states where reserves are located, is a real one. Petrochemicals could only make use of a small percentage of these gas reserves, and fuel, except in a very few industries, is not sufficiently controlling to move to a cheap fuel.

CORROSION PREVENTION AND PLASTIC PIPE SECTION

Anodes, rectifiers, and plastic pipe—three agencies in the prevention of corrosion in gas systems—are given particular attention in this issue, which is dedicated in part to the gas engineers in attendance at the National Association of Corrosion Engineers' big meeting in Chicago this month. Past GAS surveys on plastic pipe usage are supplemented in this presentation; and, because of the wide variance in properties of plastics materials, the characteristics of the two most widely used materials are discussed. A recommended method of mains installation is also included, and the section concludes with a scholarly inquiry into the relative economics of anodes and rectifiers for cathodic protection.

(And in the pipeline section, two articles—one a study of modern holiday detectors, the other a discussion of the factor of soil resistivity in establishing corrosion control.)



PLASTIC PIPE

Installation and experience data pile up as more utilities turn toward plastic pipe

Applicability under wide range of temperature and pressure conditions indicated in survey

By **WILLIAM W. CLARK** • Editorial Director

STILL feeling its way along, the gas industry in 1955 is continuing to explore the possibilities of plastic piping for both service and main installations. Perhaps the most significant aspect of this gradually accelerating development is the fact that experience years are being built up—years that will help to round out an industry-wide story sufficient to establish the proper place of plastic piping in gas distribution work.

The only argument that will clinch this wide acceptance is experience, and a great number of utilities are yet to be convinced that plastic service or main piping has enough in-the-ground years behind it to qualify it as being "experienced."

These facts were once again brought to light in the fourth GAS survey on plastic pipe, conducted last month.

The number of companies that are using plastic piping is still not impressive, but it is growing. Twelve respondents are now using plastic pipe (plus at least three others that did not respond) giving a total of some 15 companies. Last year, six companies that responded were using it, plus at least two that did not respond, or were not covered in the survey, giving a total of eight. One company that reported a year ago that it was using the material on a limited experimental basis is now laying plastic in regular, though moderate, volumes.

At least 14 other companies are using plastic on a limited or experimental basis. Two of these are limiting its use to highly specialized applications under extremely corrosive conditions.

Among the companies that declared they are still not using it, only a handful expressed the opinion that they felt it is not a "suitable" material. Many still serve manufactured gas with constituents that react on the pipe. Many others continue to be open-minded on the subject: they simply are waiting for more information and a greater span of experience on the part of the bolder companies. Some are beginning to "study" the subject.

There does not seem to be any established geographical pattern among users; across the breadth of the United States, certain key utilities are turning to plastic. Southern California Gas Co. has been using it, but so has the Gas Light Co. of Columbus, Ga. In sometimes-chilly Denver, Public Service Co. of Colorado is laying plastic on a regular schedule; and in hot, dry Tucson, Ariz., Tucson Gas Electric Light & Power Co. is an enthusiastic user. In such widely scattered locales as Battle Creek, Dallas, and Brooklyn, utilities are adopting it. And smack in the middle of the U. S. Gas Service Co. of Kansas City is scheduling 10,000 ft for insertion in 1955.

Ranges in pressures and temperatures (during installation) and in the ground also vary widely. In Tucson, plastic mains are being laid for use at pressures up to 60 lb. Service pressures among different companies range from 5.5 in. wc to 50 lb. Installation temperatures range between —10° and 110°, and underground temperatures vary from approximately —20° to 80°.

Since the majority of pipe in use is in services, pipe diameters are, for the most part, small, being generally in the vicinity of 1½ in. Wall thicknesses seem to vary from .053 in. to .14 in.

Other operating data brought out in the study showed that installation methods are somewhat short of being uniform, as set out in some detail below. But on one thing, respondents seemed to be in genaral agreement: They have encountered little or no difficulty with plastic pipe to date.

Here are some random findings:

Peoples Gas Light & Coke Co., Chicago, has had plastic piping in the ground for 2 years, 7 months, without failure. At present, the company has a total of 450,000 ft of cellulose acetate butyrate in use. All of this total is inserted in old steel pipes, using sleeves and compression fittings, internal metal back-up rings, and plastic end adaptor. Peoples likes plastic pipe, but warns "Plastic material should be purchased from reputable sources."

Brooklyn Borough Gas Co. uses Kralastic pipe, extruded by Carlon and labeled "Carlon GF flexible plastic pipe." Five services have been laid direct in the soil as a test; the remainder of the 900 ft used has been inserted. Plastic end adaptors, to 1¼-in. Dresser couplings and external sleeves have been used as fittings. After two years in the

GAS survey

ground, no failures have been experienced.

Minneapolis Gas Co. lays all of its services direct in the soil, yet all to be laid in 1955 will be for bare replacement rather than new services. It has less than 5000 ft of Tenite II (Formula 265-H2), extruded by Nebraska Plastics; some has been in the ground for seven years. Minneapolis uses Normac and Dresser couplings. Drip liquids consisting of oil are present in the sendout gas. The company reports no difficulties, but advises that care be exercised in backfilling.

Mississippi Valley Gas Co., Jackson, Miss., has had 30,500 ft of small-diameter pipe in the ground less than six months. Tenite II, formula 435E 22300, extruded by Johnson Plastics, is used. Some is laid direct in the soil, some is inserted. Dresser couplings and plastic-and-metal stiffener sleeves are used. There are no drip liquids present in the senndout gas. Mississippi Valley has had some trouble—"fabricated plastic tees fractured after installation." The company attributed its difficulties to (mainly) "inexperience of installation personnel." Although tentatively scheduling 2500 ft for installation in old services and 1500 ft for mains in 1955, the company says that "After this winter's experience record with our first full-town installation, we will then consider the advisability of using plastic for additional installations."

In the three years that City Utilities of Springfield, Mo. has had plastic pipe in the ground, one plastic service renewal has broken at the main end adaptor, and this occurred during backfilling work in cold weather. Springfield has installed plastic at temperatures as low as 20°. A used of cellulose acetate butyrate, Springfield has 900 ft in the ground, plans to install 1000 ft this year —all service insertions.

C. H. Webber of Tucson (as noted elsewhere in this issue) is a firm believer in the importance of proper foundation and support, with steel cover protection on mains. He reports no troubles in the two years he has used the material; in 1955, Tucson will lay 5000 ft of services and 6000 ft of 2- and 4-in. main.

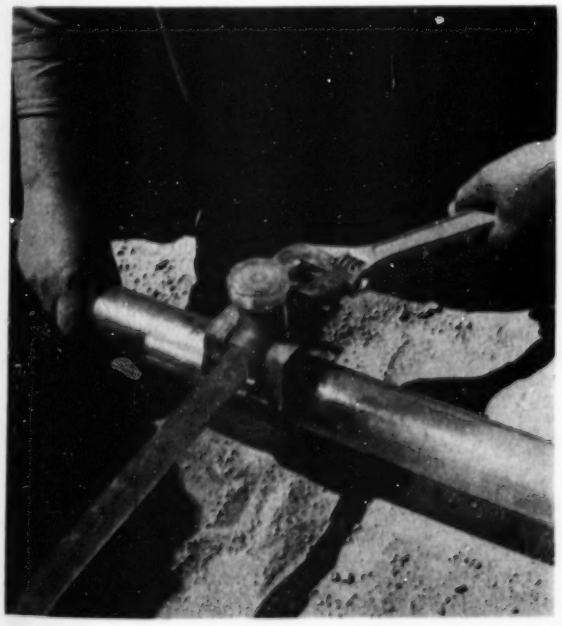
Milwaukee Gas Light, which turned to plastic in May 1953, uses both butyrate and polyethylene. One thousand ft of mains and 5000 ft of service piping, all for insertion, will be laid in 1955. To date, the installations have been trouble-free, although the company takes extra precautions with joints. "Exposed joints are blocked on the bottom and covered with plank," reports Donald N. Koehler. "Backfilling is done by hand to a depth of 6 in. over planking."

Battle Creek (Mich.) Gas Co. has also managed to avert trouble during the two years plastic services have been used. Compression fittings with seamless steel inserts are used to prevent crushing at joints. Open ends of the pipe (which is inserted in old services) are covered with long nipples cut lengthwise in half.

Gas Light Co. of Columbus (Ga.) reports two incidents in 250 services, over a period of from two to six months. At each end where the service enters the main, and at the house end, metal-cased plastic adaptors are used. In both cases, breaking out of the metal-cased

Replies from two additional users were received too late for inclusion in this article. Ohio Fuel Gas Co., Columbus, is testing Carlon G.R. for services laid direct in the soil. Pressures run to 50 psi. External sleeves, cement, compression couplings, and plastic end adaptor are used for joints. After one year, no difficulties have been encountered.

Mountain Fuel Supply Co., Salt Lake City, has 20,400 ft of 1 1/16-in. service line in operation at pressures up to 50 psi. Tenite II is used both in soil and inserted. In 1955, 5000 ft will be laid. In 3½ years, mitered joints have broken and had to be replaced and two bells have leaked where bell-and-spigot pipe was used.



Installing a plastic service fitting. Steel installation clamp holds the plastic fitting in place during drilling operations, after which it is removed.

Tucson (Ariz.) Gas Electric & Power Co.

What do extruders think of the market for plastic pipe?

Says George A. Stein of A. O. Smith Corp.:

"Recent market analyses indicate that by 1960, plastic pipe will be the largest single end use for plastic materials. . . ."

Mr. Stein, whose remarks were directed to the 10th annual meeting of the Reinforced Plastics Division of the Society of the Plastics Industry, held last month, gave the members some encouragement on the market for their product. Their present share of the market is some 10%. But beyond this limit, he foresaw some rapid strides for the entire plastic piping market.

Eight major segments of this market were listed, including what he termed "gas transmission lines." Another was "oil fields and oil production," and using this use as an example, he said that "based on use estimates, the production figures for 1960 could be astronomical. The oil fields are not the largest user, or largest potential user, yet they consume 60 million ft of pipe per year. Projected estimates show it is probable that more than 400 million ft of *reinforced* pipe will be used per year if technology advances as expected."

Installation and operating data from 12 users of plastic pipe

Name of User	Direct or Insert	OD	Pressures	Installation Temp.	Ground Temp.	Footage in	1955 Footage	Type	Years in Ground	Sendout Gas
Minneapolis Gas Co.	Direct	½ in.	10 psi, 6 in.	—	—	5000	—	Tenite II	7	Natural
Mississippi Valley Gas Co.	Both	1.05-2.5	50 psi	85-100	70	30,500	4000*	Tenite II	4 mo.	Natural
Peoples Gas Light & Coke	Insert	1⅜	6 in.	80	15	450,000	200,000	Tenite II	2 yrs, 7 mo.	Mixed: 90% nat.; 10% coke oven
Brooklyn Borough Gas	Both	1.25 in.	6 in.	50-90	60-70	900	750	Kralastic	2	Natural
City Utility of Springfield, Mo.	Insert	1⅛	40 psi	20-100	40-60	900	1000	Tenite II	4	Natural
Gas Light Co. of Columbus, Ga.	Both	.855 to 1.420 in.	50 psi	40-75	—	18,000	1000	Butyrate	2-6 mo.	Natural
Battle Creek Gas Co.	Insert	1⅛ in.	35	20-95	32-50	—	2000	Tenite II	2-6 mo.	Natural
Milwaukee Gas Light	Insert	½ in.	6 in, 12 psi	20-80	45-50	1636	6000**	Butyrate and Polyethylene	2	Natural
Tucson Gas, Electric Light & Power	Mains: direct Services: insert	¾-4 in.	60 psi	40-100	60-90	26,000	11,000***	Tenite II and Butyrate	2	Natural
Gas Service Co.	Mostly insert	1.14 in.	15 in., 35 psi	25-100	—	6000	10,000	Butyrate	2-3	Natural
Arizona Public Service Co.	Mostly insert	⅝ in. and ⅞	15 psi, 28 in.	55-110	35-85	30,000	30,000	Tenite II Kralastic	2	Natural
Public Service Co. of Colorado	Both	1.050	to 15 psi	—10 to 100	20-75	230,000	125,000	Tenite II Form 435	4	Natural

*Includes 1500 ft for mains. **Includes 1000 ft for mains. ***Includes 6000 ft for mains.

adaptor was reported. Gas Light uses special care in backfilling and tamping under pipe where it has plastic-to-metal joints; at other points, a flat trench is a must.

Public Service Co. of Colorado, Denver, continues to be well satisfied with the performance of plastic services. In the four years since the company first began installing it, "very few failures" have been encountered. "These could be charged to human factors," says J. F. Fugazzi, maintenance engineer. In 1954, more than 100,000 ft was installed, to bring the total in the ground to date to 230,000 ft. In 1955, 125,000 ft will go into service, 50,000 for new services, 75,000 for insertion in old pipes. Public Service uses no special precautions (other than care, of course) except a compression coupling equipped with an armored tip gasket.

Arizona Public Service Co., Phoenix, has had no unusual experiences with the 30,000 ft of new and inserted plastic services, some of which have been in the ground for two years. Earl Jorgensen expects to use another 30,000 ft for services this year, and may experiment a bit with mains.

The Gas Service Co., Kansas City, Missouri, division, has had 6000 ft of 1-in. pipe in the ground for from two to three years, most of which has been for inserts, and plans to install an additional 10,000 ft of inserted pipe in 1955. The only troubles Gas Service encountered were blamed on an extruder (from whom the company no longer buys) who failed to maintain OD and ID tolerances, causing some failures at solvent joints.

This year, 13 companies reported they were using plastic pipe on either a limited or experimental basis. Two companies are limiting their applications, at least for the present, to unusually corrosive locales. Both use reinforced plastics. Consolidated Gas Utilities Corp., Wichita, Kan., has lines running through salt plant yards. Because of soil conditions, 1200 ft of Perrault Fibercast thermosetting plastic pipe, fabricated of polyester resins reinforced with glass fibers, were laid. The major portion of the pipe, which is 4½-in. OD, was inserted through an 8-in. Dresser-coupled line. Division Superintendent W. M. Habernigg says "This was necessary because of railroads and salt water ponds, and for protection of pipe replacement and other construction work through salt plant yards."

Equitable Gas Co., Pittsburgh, has taken delivery on 260 ft of similarly reinforced plastic pipe manufactured by

Companies using plastic pipe on a limited or experimental basis

Iowa-Illinois Gas & Electric Co.
Consolidated Gas Utilities Corp.
Washington (D. C.) Gas Light Co.
Southwest Natural Gas Co.
Lone Star Gas Co.
Equitable Gas Co.
Southern Union Gas Co.
Central Indiana Gas Co.
Roanoke Gas Co.
Northwestern Public Service Co.
Consumers Power Co.
Public Service Electric & Gas Co.
Wisconsin Public Service Corp.
Lone Star Gas Co.
United Fuel Gas Co.

Standby or Peak	Drip Liquids	Joints: Plastic-to-Plastic	Joints: Plastic-to-Metal	Special Fittings and Inserts
LPG-air	Oil	No	Compression couplings.	No
—	No	Yes, external sleeve, solvent.	Yes, compression couplings, internal metal backup ring, and plastic end adapter.	Plastic and metal stiffener sleeve.
—	Slight oil and water	Yes, internal sleeve; solvent and cement.	Yes, compression coupling; internal metal backup ring.	Compression fitting.
High-Btu oil-gas	Oil and water	Yes, external sleeve.	Plastic and adapter to 1¼-in. Dresser coupling.	Plastic and adapter to 1¼-in. Dresser coupling.
—	—	Ethyl acetate solvent and external sleeve.	Compression coupling.	At main end of service male thread plastic adapter screwed into street ell on service tee and at house end Dresser coupling of steel and plastic adapter of same OD.
LPG-air	No	Yes, internal and external sleeves; solvent and cement.	—	Metal-cased plastic adapter at main and house ends.
LPG-air	No	Yes, internal sleeve; solvent and cement.	Yes, rubber gasket coupling and adapter fittings; compression plastic end to standard pipe thread with 1-in. by 6-in. seamless steel nipple inserts.	At main end of service, 1¼-in. by 1⅛-in. adapter ells. At house end, adapter tees.
—	—	Yes, internal and external sleeves with solvent and cement.	Yes, compression coupling; internal backup ring; plastic end adapter.	At each end entering main, plastic-to-metal flange union adapter. At main end of service, compression coupling tee. At house end of service, wall adapter.
—	No	Yes.	Dresser compression coupling; internal metal backup ring; plastic end adapter.	At each end entering main, steel and/or plastic service tees. At main and house ends, compression fittings.
—	No	Yes, with internal and external sleeves and solvent.	Yes, compression coupling.	At main end of service, plastic adapter and compression coupling; at house end, connections to steel pipe 5 ft from building.
—	—	Yes, external sleeves and solvent.	Yes, compression coupling; internal metal back-up ring and plastic end adapter.	At main and house ends, Dresser Style 90 ½ welded to ¾-in. steel.
—	None	Yes, solvent-weld with external sleeve and cement.	Compression coupling and internal metal back-up ring.	At main end, plastic pipe connected to standard metal fittings with compression coupling. At house and outside belowground installation: plastic compression coupled to steel pipe. Normac adapter bushing 1093-A where plastic is extended through old steel pipe to inside face of building wall.

Youngstown Sheet & Tube Co. This will be used in a river crossing where, according to G. W. Stuart, assistant general superintendent of distribution, "mine water makes corrosive action very great. We also plan to use 1¼-in. service line in our own properties. Several types will be experimented with." For the river crossing, 3-in. line is being used. Joints will be threaded and coupled with one end of coupling cemented to the pipe. Consolidated uses threaded plastic nipple and coupling at each end of the main.

Consolidated, incidentally, has had its pipe in the ground for two years. The only trouble encountered was the failure of one joint to seal and damage to the run of pipe by torch flame.

Among those companies presently experimenting with plastics, the following difficulties have been noted:

"Tubing sheared at one compression joint; probably due to weight of grading equipment on short exposed flexible tubing. Oil gas use exceeded expectations in 1954; tubing exposed to oil gas softened and required replacing." (Washington Gas Light Co.)

"Major difficulty has been at points where a service saddle type of fitting has been installed." (Southern Union Gas Co.)

Wisconsin Public Service Co. is one of the few companies that report any experience with polyethylene. The company has had 300 ft in the ground for a year, and has encountered no difficulties as yet. Dresser compression couplings are used with internal copper backup rings at joints. ■

New rubber cap prevents dust from entering curb meters

Plugs or cork and other materials, caps of various kinds of metal, plastic caps, cardboard covers, and a variety of other devices have been used to close the openings in the inlet and outlet connections of curb meters while they are in transit or in meter repair shops. But now a new, better "dust" cap has been produced.

The West American Rubber Co. of Los Angeles participated with the meter shop personnel of the Southern California Gas Co. in the development of a rubber cap that prevents foreign material from entering curb meters and protects the swivels and threads on the meter connections. These caps (see illustration) cannot be dented out of shape or forced into the meter. They stay on when installed and save time during installation. Users of these devices report that they are economical and are the answer to the problem of capping curb meters.

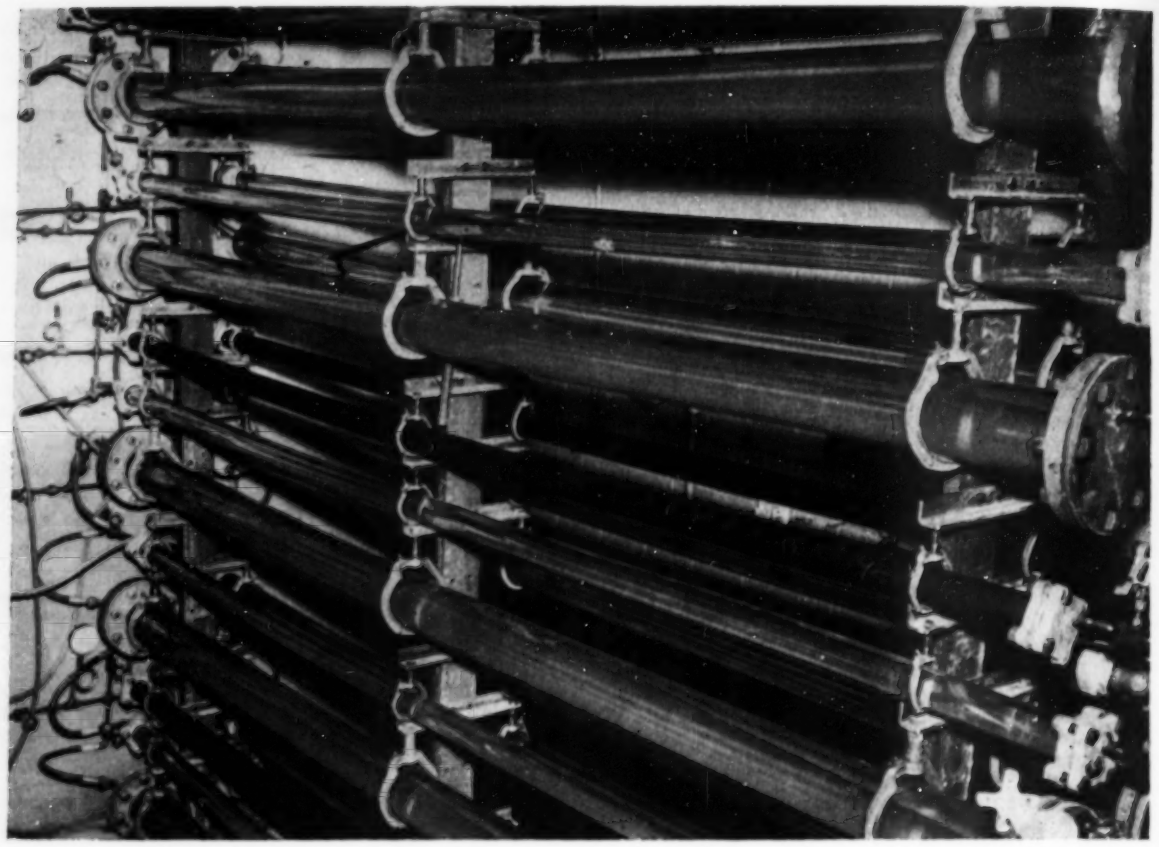


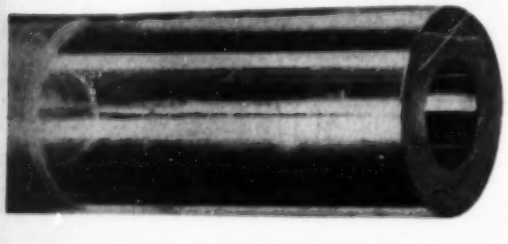
Fig. 1. Tenite butyrate pipe on test rack.

What continuing tests show

Long-term creep of pipe extruded from Tenite butyrate plastic

By **L. W. A. MEYER** and **R. J. SCOGIN** • Tennessee Eastman Co., Kingsport, Tenn.

Occasional failures in use may be traceable to excessive temperatures or pressures, and with this thought in mind Tennessee Eastman has undertaken long-term tests to provide data on creep under internal pressure of plastic pipe used in the gas and oil industries and in structural installations. This article, adapted from an interim report prepared by the company, brings up to date the information published by Tennessee Eastman in a preliminary report last October.



PLASTIC PIPE

A CONSIDERABLE quantity of pipe extruded from Tenite Butyrate plastic has been used successfully in the gas industry for natural gas service lines and in the oil fields for transporting salt water and sour crude oil. Although there have been a few failures reported in the oil fields, investigation has indicated the possibility that most of these had been due to excessive temperatures and/or pressures. A few are believed to have resulted from contamination of the plastic extrusion material or the fact that the pipe was not extruded under optimum conditions. At

any rate, it is hoped that the long-term creep data obtained to date from these continuing tests will prove useful as a guide for the design of service installations to employ butyrate pipe, pending completion of the tests and publication of the final results.

Nine-foot lengths of four different sizes of pipe were used in the tests. They were mounted on racks, filled with water, and maintained under different internal pressures. The outside diameters of the pipes were measured periodically. The resulting curves show the percent increase in outside diameter for the different sizes of pipe plotted against time. Internal pressures and hoop stress data (unit fiber stress) also are indicated for each pipe size. The ultimate objective is to determine the highest safe hoop stress which any given size pipe will withstand. The hoop stress is used in calculating the safe working pressure for a given size pipe or for determining the wall thickness necessary to withstand a given pressure.

The information will be presented as follows:

1. Nominal dimensions of the four different sizes of pipe tested.
2. Pipe extruded from two different formulas of Tenite Butyrate, each tested at two different temperatures, presented in four groups.
3. Photographs of the test racks and explanation and discussion of equipment and test procedures.
4. Explanation of the method of calculating the hoop stress values.
5. Four graphs summarizing creep data on the four groups of pipe.
6. Table showing the safe hoop stress values from these preliminary test data for each group, with corresponding tensile strength data.
7. Graph showing creep of 4.500-in. OD butyrate pipe with 0.250-in. wall during 4½ years of continuous service in an outside installation at 95-105 psi internal water pressure.

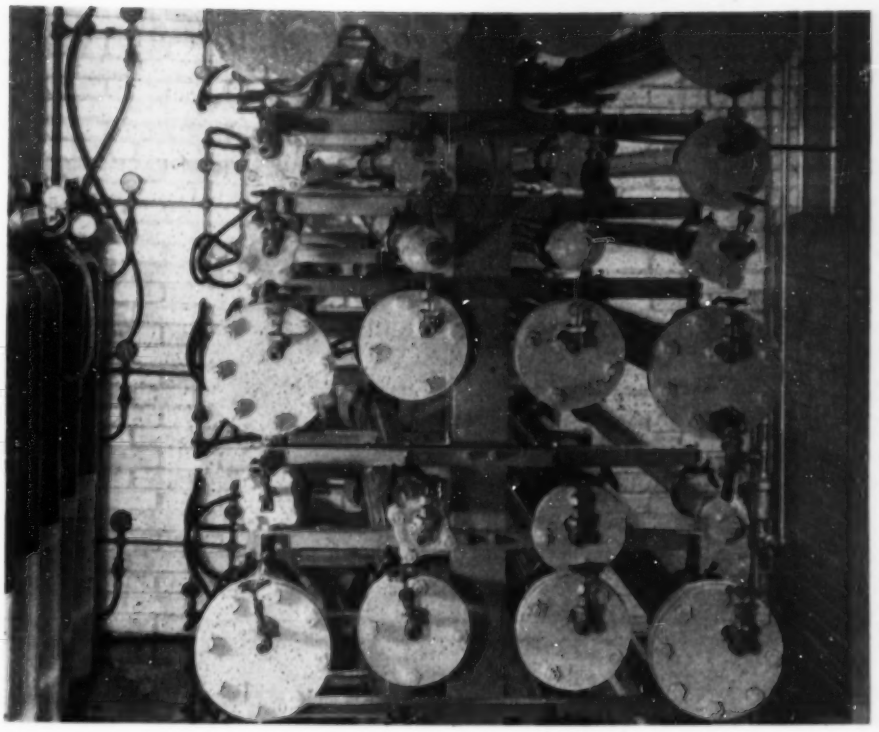


Fig. 2. Tenite Butyrate pipe on test rack, showing nitrogen cylinders and pressure gauges.

Sizes and formulas of Tenite Butyrate pipe tested

Four different sizes of butyrate pipe, wet, were evaluated by long-term creep data. These are shown in *Table 1* along with the dimensions of each.

TABLE 1. SIZES OF TENITE BUTYRATE PIPE TESTED

Nominal Size Inches	Types	Dimensions, Inches O.D.	I.D.	Wall
2	SWP	2.250	2.000	0.125
2	IPS	2.375	2.067	0.154
3	IPS	3.500	3.068	0.216
4	*	4.500	4.000	0.250

*O.D. same as for IPS; Wall .013 in. greater.

TABLE 2. TEST GROUPING OF TENITE BUTYRATE PIPE

Group	Formula	Test Temp. ° F
A	*435E-22300-MH Clear	Room
B	265E-20337-MH Black	Room
C	435E-22300-MH Clear	120
D	265E-20337-MH Black	120

*Formula 460 is now being suggested for extruding clear pipe since it contains an improved ultraviolet inhibitor.

TABLE 3. SEALS ON PIPE ENDS

Size Nominal Inches	Type	Type of Fitting
2	SWP	Tapered plugs with tapered back-up flanges and Garlock gasket.
2	IPS	Compression fittings and Van Stone flange assembly (circular end-plate with Garlock gasket).
3	IPS	Van Stone flange assembly.
4	(See Table 1)	Van Stone flange assembly.

TABLE 4. SAMPLE CALCULATION

$$S = \frac{P \times O.D.}{2 \times T}$$

$$S = \frac{90 \times 2.242}{2 \times 0.119}$$

$$S = 850 \text{ psi}$$

Values

S = Hoop stress psi

P = Internal pressure psi

O.D. = Outside diameter = 2.242"

T = Wall thickness = 0.119"

Long-term creep data . . . How the tests are conducted

TABLE 5. SUMMARY OF SAFE HOOP STRESS VALUES FROM EACH GROUP

Group	Tenite Butyrate Formula	Hoop Stress Psi*	Test Temp. ° F	Tensile Strength at Fracture Psi**
A	435E-22300-MH Clear	1010-1180	Room	4680†
B	265E-20337-MH Black	810-1015	Room	4460†
C	435E-22300-MH Clear	755-935	120	4020
D	265E-20337-MH Black	740-845	120	4060

*Optimum from these tests. †At 100° F.
**ASTM D638-52T.
Conditioned by ASTM D618-51T, Procedure A.

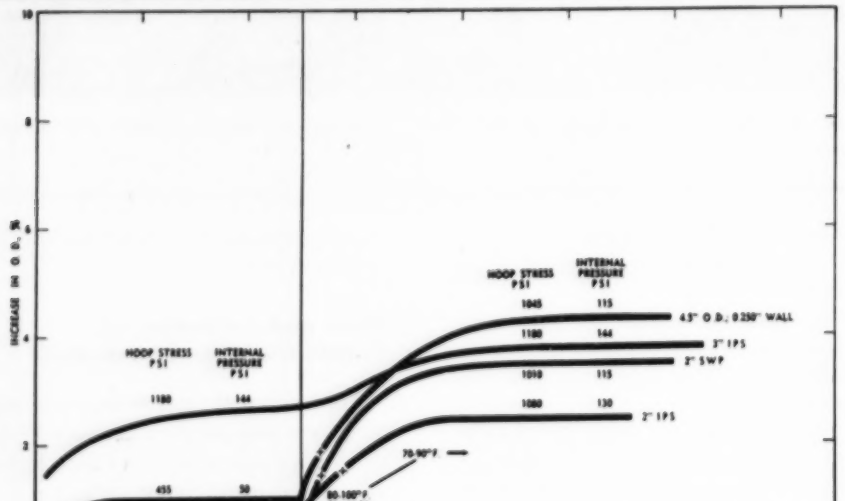


Fig. 3 (Group A). Summary of creep data on Tenite Butyrate pipe (wet) at room temperature (435E-22300-MH clear).

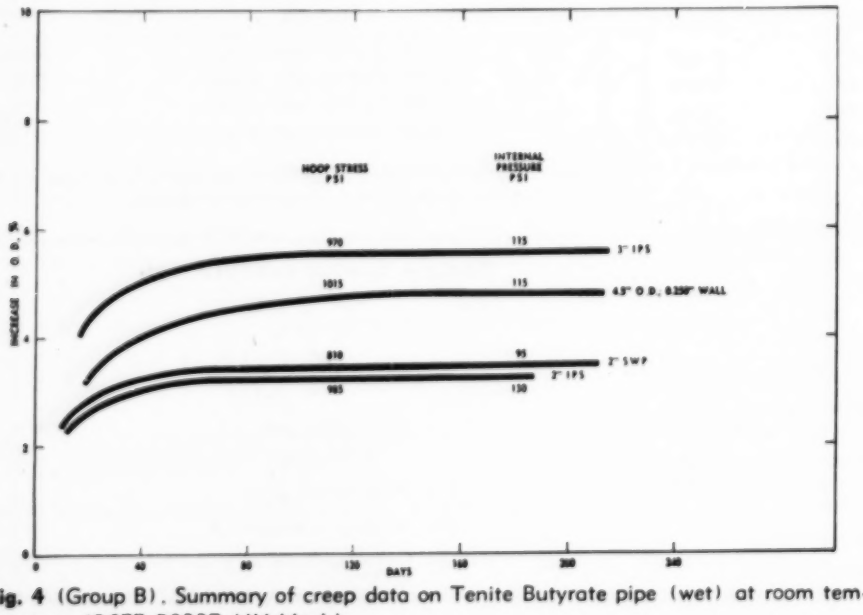


Fig. 4 (Group B). Summary of creep data on Tenite Butyrate pipe (wet) at room temperature (265E-20337-MH black).

Each of the four sizes of pipe was tested, wet, in two different formulas at two different temperatures and at five different pressures. Four test groups, each comprising all four sizes of pipe, were arranged as shown in *Table 2*.

Test rack, equipment and procedure

Photographs of the test racks are shown in *Figs. 1* and *2*.

The test pieces were supported horizontally on standard pipe hangers spaced at about 4-ft intervals. The ends of the pipe were free, not rigidly held in compression or tension.

The water was held in the pipes by sealing the ends as shown in *Table 3*.

After the pipes were filled with water, pressure was applied from cylinders of nitrogen. The pressure was regulated by standard reducing valves. A check valve was installed in the line between the nitrogen cylinder and the water in each line. Ashcroft gauges were used in each system. Needle valves were used between the inlet water line and each pressure system as well as a control valve for each two test pieces. Chart recorders were used to record the temperature.

The test rack for Groups A and B was erected in a room which was steam-heated during the winter, with a room temperature variation of about 70-90° F. This range increased to about 80-100° F during the summer months.

The test rack at 120° F for Groups C and D was erected in a room containing a vertical unit steam heater with a fan and Anemostat mounted about 27 in. above the test rack. An inverted V-shaped hood of sheet metal was used to prevent the hot air from making direct contact with the pipes near the top of the rack. The temperature was held at 120 ± 4° F within the test area (from the top to the bottom and end to end of the test rack) by the use of a Foxboro temperature recorder-controller. This instrument operates a diaphragm motor valve in the steam line.

Pipe measurement

The diameter of each pipe was measured at four different places with a flat steel tape, Starrett No. 510-J, which has a pi scale on the back. The scale is graduated in 64ths but can be estimated to the closest 128th of an inch. In general, the largest dimensions from each of the four measurements were used in calculating the percent increase in outside diameter.

Continued on page 69

Long-term creep data...

Calculation of hoop stress values

Barlow's formula was used to calculate the hoop stress for each pipe. A sample calculation is shown in *Table 4* for 2-in. SWP butyrate pipe, formula 435E-22300-MH clear, tested at 120° F under 90 psi internal pressure.

The actual dimensions for outside diameter and wall thickness, rather than the nominal dimensions, were used in the calculations. Slide rule calculations were used since they are within the range of experimental error. Also, the hoop stress values were rounded off to the nearest 5 psi.

Discussion of graphs

The percent increase in OD was plotted against time for each pipe in each group. It is characteristic for butyrate pipe to creep some, even at normal temperatures and at pressures as low as 50 psi. The creep usually continues gradually until the curve approaches a horizontal line. The individual pipe may then be considered as having reached an equilibrium state.

The data presented in *Table 5* represent the safe hoop stress values for the four different sizes of pipe in each group.

All of the test pieces are being continued under test except those identified on the graphs as follows:

B = Burst

R = Removed because of excessive swelling

R (E) = Removed in error

Group A

(See *Table 5* and *Fig. 3.*)

This group represents the first tests conducted on Tenite Butyrate pipe under sustained internal water pressure. The five different internal pressures arbitrarily chosen were 50, 75, 95, 144, and 200 psi. The room temperature range during most of the test period was 70-90° F. This increased to 80-100° F during the summer months, which accounts for the further increase in OD.

After about 150 days it was decided to discontinue testing at the highest pressure of 200 psi because most of the pipes failed under this pressure. These were replaced with new specimens at 165 psi. The lowest pressures, 50 and 75 psi, were considered to be too low

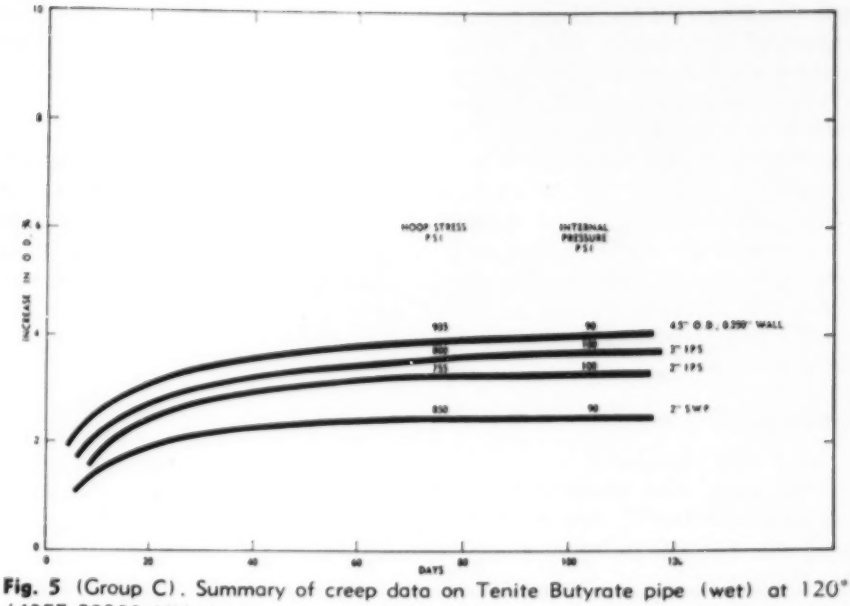


Fig. 5 (Group C). Summary of creep data on Tenite Butyrate pipe (wet) at 120° F (435E-22300-MH clear).

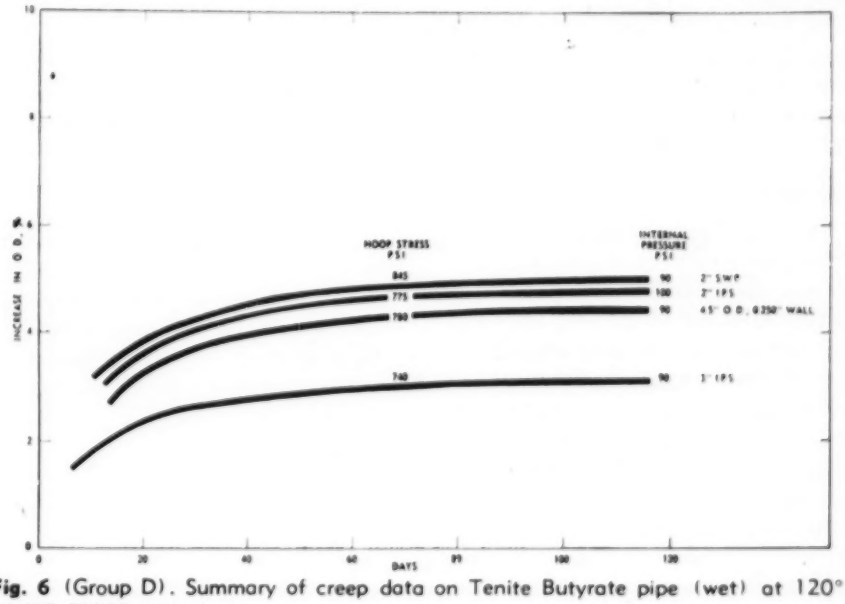


Fig. 6 (Group D). Summary of creep data on Tenite Butyrate pipe (wet) at 120° F (265E-20337-MH black).

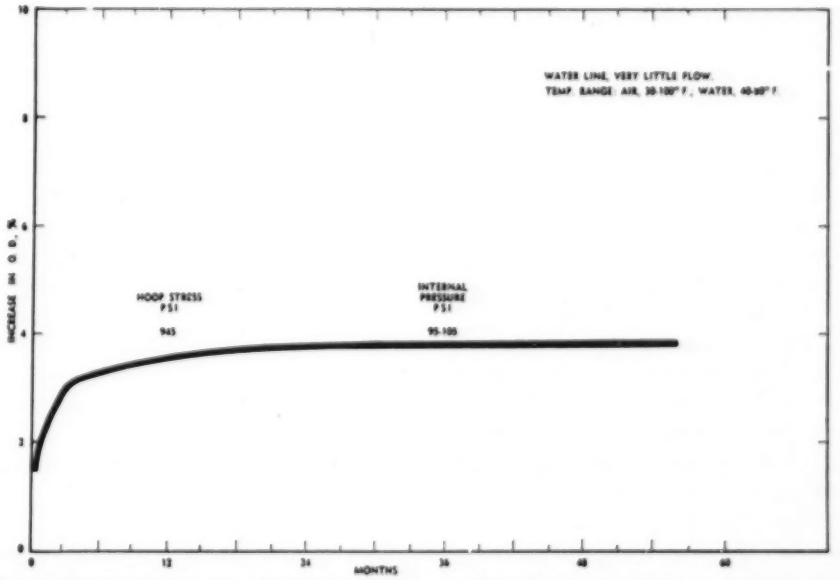


Fig. 7. Creep of 4-in. Tenite Butyrate pipe (wet) outside installation—4.500-in. OD; 0.250-in. wall (205E-22300-MH clear).

since the curves for the 95-psi system approached a horizontal line. These pressures were increased to 115 and 130 psi respectively, which caused a further increase in OD of these pipes. The pressures of 95 and 144 psi were not changed.

The highest safe hoop stress for the four different sizes of pipe in these tests varied from 1010 to 1180 psi. The corresponding maximum increase in OD was 2.5 to 4.3%, for a total time of 360 days.

Group B

(See *Table 5* and *Fig. 4.*)

These pipes were mounted on the same rack as those discussed under Group A. The four different sizes of pipe were tested, wet, at the newly assigned pressures of 95, 115, 130, 144, and 165 psi.

The highest safe hoop stress for the four different sizes of pipe in these tests varied from 810 to 1015 psi. The corresponding maximum increase in OD was 3.3 to 5.5%, for 210 days.

Group C

(See *Table 5* and *Fig. 5.*)

Four different sizes of pipe were tested, wet, under five different arbitrarily chosen pressures of 80, 90, 100, 110, and 120 psi at a controlled temperature of 120° F.

The highest safe hoop stress for the four different sizes of pipe varied from 755 to 935 psi. The corresponding maximum increase in OD was 2.5 to 4.1% for a total of 116 days.

Group D

(See *Table 5* and *Fig. 6.*)

The pipes in this group were mounted on the same rack as those discussed in Group C. Four different sizes of pipe were tested, wet, under five different arbitrarily chosen pressures of 80, 90, 100, 110, and 120 psi.

The highest safe hoop stress for the four different sizes of pipe in these tests varied from 740 to 845 psi. The corresponding maximum increase in OD was 3.1 to 4.8%, for a total time of 116 days.

Fig. 7 shows creep data on butyrate pipe which has been in service continuously for 4½ years at 95-105 psi internal water pressure. This is an outside installation about 10 ft long, with very little flow. The air temperature range is about 30-100° F and water temperature range is about 40-80° F. The pipe was extruded from formula 205E-22300-MH Clear, with 4.500-in. OD, 0.25-in. wall. The highest hoop stress to which this pipe is subjected is 945 psi. The tensile strength of the material is 5320 psi at 80° F or 4670 psi at 100° F. The OD has increased about 3.8% and has been relatively constant since the first 16 to 20 weeks. This indicates that the outside diameter may expand in the range of 3.5 to 4.0%, more or less, with continued satisfactory service.

Summary

In planning service installation it is suggested that consideration be given to the safe hoop stress values shown in *Table 5*. These represent only about 15 to 20% of the short time tensile strength.

Previous estimated safe working pressures for pipe extruded from Tenite Butyrate have been calculated on an arbitrarily chosen basis of 20% of tensile strength. A considerable quantity of butyrate pipe has been installed on the basis of this guide and, in general, it has proved satisfactory. The data in this report roughly confirm these previous assumptions.

The tests described in his report were run at a constant pressure and were not subjected to impact loading caused by water hammer or by external force.

It is planned to continue these long-term creep tests to obtain the highest safe hoop stress values for various temperatures.

An attempt will be made to correlate the data thus obtained with short-time tests on tensile bars, wet, at the same temperatures as used for the creep tests.

This report is for information only. The technical advice supplied in it is furnished without charge. Eastman Kodak Co. and Eastman Chemical Products Inc., which are, respectively, the producer and seller of Tenite Butyrate, must necessarily disclaim responsibility for all results of such advice and of the use of the products, methods and apparatus mentioned herein. It is the user's responsibility to determine suitability for the user's purpose of any products, methods or apparatus mentioned in this report and to adopt such precautions as may be advisable for the protection of property and health of persons against any hazards that may be involved in the handling and use thereof. No statement or suggestion in this report is to be considered a recommendation or inducement of any use, manufacture or sale that may infringe any patents now or hereafter in existence.

Plastic Pipe

How to replace steel mains with plastic pipe

PLASTIC pipe, being immune to the corrosive action of soils, would seem to be a logical and economical solution to the problem of replacements of steel pipe, particularly where such replacements are of short distances and where the installation of cathodic protection is not feasible because of its initial and recurring costs.

Plastic pipe standards are being established, and the major types of plastic materials used in the production of pipe for natural gas distribution can be safely and economically used.

With prescribed wall thickness, pressures up to 60 psi at 100° F temperature can be safely handled. Distribution pressures and temperatures seldom approach these points.

Because of the nature of the material, the techniques employed in installing it are important. These installation instructions on the next page have been developed as a result of our experience with plastic mains.

Installation instructions

Usually the replacement of steel pipe with plastic mains, made in highly corrosive soils, will be located under pavement.

Bell holes should first be dug at each end of the main to be replaced, and Mueller line stoppers installed. If necessary, a bypass should also be used.

Old steel main should be uncovered

→

GAS exclusive

By C. H. WEBBER, Vice President
Tucson (Ariz.) Gas, Electric Light & Power Co.

Assembling 2-in. plastic pipe above ground. Ends of pipe should be inserted in coupling or sleeve until junction is made, either by ends or by shoulder, in the coupling.

to a point where one-half of the pipe is exposed. The trench should only be wide enough to remove the old pipe. For 2-in. and 4-in. mains, a width of from 8 in. to 10 in. is recommended; but it should be dug so that the uncovered pipe will be approximately in the center line of the trench, as the dirt cradle left by the steel pipe should be used as a foundation in which to place the plastic.

After the flow of gas has been controlled by line stoppers, the main should be cut at both ends, and the pipe carefully lifted vertically from the trench, using due caution so as not to disturb the walls of the cradle and preserving a firm foundation for the plastic. The steel pipe should be cut as near the trench as possible in order that the plastic will rest on undisturbed soil, allowing only enough room for installing compression fitting.

Assemble above ground

Plastic pipe should be assembled above ground. The pipe must have true 90° ends, so that when it is inserted in couplings or sleeves, the ends will either be flush with the shoulder in the coupling, or, in the case of sleeves, will meet. This is the point where leakage is controlled. Before applying solvent, couplings or sleeves should always be tested for size. A tight fit is mandatory.

Solvent should be applied liberally to both the inside of the coupling or sleeves and the end of the pipe to be inserted. The seal will occur at the point where the pipe meets the shoulder of the coupling, or where the two ends meet in the sleeve. The solvent should be scrubbed in with a soft camel's hair brush. The pipe should then be shoved into the coupling or sleeve until the end of the pipe makes contact, at which time it should be turned slightly.

The assembly should be held in place for a matter of a minute or so, which will give sufficient time for the solvent to set, providing there is no strain on the pipe. After the joint is complete, solvent should be brushed around the connection.

The old removed steel pipe should be cut longitudinally into two equal halves, each of which is cut into 3-ft lengths. After all scale and welding drippings have been cleaned from the interior, it should be expanded, as it will be used as a cover for the plasitc. Two-inch steel pipe can be expanded sufficiently by placing it on a 3-in. form and hammering with a sledge hammer or by placing it in a vise.

For 4-in. pipe, a 5-in. form should be used. The steel pipe acts as protective to the plastic, and, being in 3-ft lengths, it can be removed in the future should it be necessary to install a service line or make an inspection. The steel also acts as a medium in using a pipe locator, as well as distributing the weight of the backfill.

Next step

Next a grout should be prepared, using on adobe soil, or, in the case of ordinary dirt, a small admixture of fireclay, thus giving it some consistency. Enough water should be added to make it flow. With a spout-can, sufficient grout should be poured into the cradle left by the steel pipe to fill all voids. The plastic pipe should then be placed in the grout and gently pushed down. Grout should then be poured onto the plastic and the 3-ft sections of steel pipe placed thereon.

A plastic service tee should be installed at one end of the relay for purging and testing purposes.

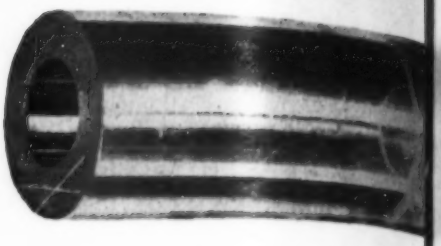
The practice of pulling a smaller size plastic pipe through a larger, abandoned steel pipe, as is now a common practice in replacing small service pipes, appears to be impractical with mains of larger sizes. If such a procedure were followed, it would be impossible to make future service connections to the main, as there would be no safe method of cutting through the steel to reach the plastic.

Costs

Out-of-pocket costs in preparing the old steel main for a covering would be only for acetylene and oxygen for cutting the pipe. A welder is always necessary of the job to weld line stoppers to the steel main, and as his remaining time is incidental to the actual installation, such time can be employed in fabricating the covering.

Should actual labor costs be considered, the costs per foot would be comparable, if not less, than the cost of installing anodes or other protection.

The purpose of the steel cover is to protect the pipe from possible damage from some sharp instrument, as well as to furnish a means for establishing the exact location of the plastic pipe. Being in 3-ft lengths, service connections can be installed and the main itself inspected from time to time. ■



An introduction to "Kralastic"

By DR. PAUL M. ELLIOTT, Manager of Kralastic Development
Naugatuck Chemcial Division of United States Rubber Co.

Several hundred feet of Kralastic is ditched at Heidelberg, Miss. A three-man crew installed approximately 4000 ft of the pipe in a day. It is part of what is believed to be the longest plastci pipeline in the country.

WHAT is "Kralastic"?

The nitrile rubbers, prepared by copolymerizing acrylonitrile with butadiene, have long been known for their chemical and oil resistance. Similarly the copolymers of acrylonitrile with styrene are highly resistant to chemicals and oils. Combining these two types of acrylonitrile copolymers have given a family of gum plastics or alloys that are chemically resistant and combine in a unique way the hardness and heat resistance of the resin with the toughness and low temperature properties of the rubber. This family of products has been named "Kralastic." It has a unique combination of properties and can be extruded and injection-molded to give lightweight, rigid, chemically resistant pipe and fittings, setting new standards of toughness and chemical resistance.

Pipe sizes

Pipe and standard fittings are made from Kralastic by many manufacturers in two main size classifications. These are: (1) Standard IPS (Iron Pipe Standard) sizes either in standard wall thickness, schedule 40, or heavy wall, schedule 80, for use with threaded fittings in, for example, chemical and plant installations; and (2) Standard SWP (Solvent Weld Pipe) sizes for use in long line installations such as oil, gas, brine, water, or drainage lines. IPS sizes can be used for long lines if desired, and SWP can be used in plant installations.

For the gas industry the plastic pipe manufacturers have recently agreed to supply SWP (API-5L) outside diameter pipes for new service work. For "insert" services a special range of sizes having the outside diameter of copper tube ASA Spec. B-88 have been set. Each manufacturer sets and maintains suitable size tolerances and these figures are available from the individual pipe manufacturers.

Burst pressure

An important question in many pipe installations is: "What pressure will the pipe withstand?" To answer this question much data have been accumulated. Results of simple burst tests are among the first data obtained. Values will vary with the rate of pressure buildup, the temperature, the dimensions of pipe, and other factors. Typical burst values range as shown in *Table 1*. The range in burst pressures is wide and correlation is difficult. Recourse has, therefore, been made to formulas, which, by expressing burst strength in terms of the tensile constant of the material and the dimensions of the pipe, have permitted correlation of data obtained on pipe of different dimensions. The formulas also permit calculation of burst strength for sizes of pipe not available for test.

TABLE 1. ROOM TEMPERATURE BURST VALUES

	½-in. Pipe	4-in. Pipe
Solvent weld line pipe	950	400
IPS Schedule 40	1400	500
IPS Schedule 80	1750	650

Two common formulas *(Table 2)* are

used to calculate burst. The simpler Barlow formula considers only the radial stresses in the pipe, which, of course, lead to tensile stresses in a circumferential direction. The more complex Lamé formula is derived in such a way that the longitudinal stresses are also considered. This formula is probably a bit more conservative; it represents the results that would be expected in service or in testing with free capped ends, and most important of all, it has been found in our experience to give best agreement with experimental data when several sizes of pipe are tested and the tensile constant is calculated. The tensile constant is not necessarily the same as the tensile determined by standard ASTM methods for the exact value of the constant will vary with the testing technique. For instance, on a given type of pipe, constants as determined from tests made in different labs have ranged from 4000 to 5000. Study of testing variables will no doubt show up the reason for this variation.

Using the Lamé formula to calculate the tensile constant, we have studied the variation of this constant with temperature. A typical curve is shown in *Fig. 1*. The change in tensile constant has seemed to be a straight-line function with temperature. Meager data indicate that the slope may be somewhat dependent on test methods, but that if the method is held uniform the function is a straight line within the range of temperatures tested.

In running burst tests it has been observed that Kralastic pipes, when subjected to gradually increasing pressure, will withstand a peak pressure some 10 to 15% above ultimate burst before they begin to swell markedly. Nevertheless, it has been a general practice for pipe manufacturers to recommend as safe working pressures, a figure that is never more than 25% of the burst pressure and is usually less than 20% of burst. This gives a "factor of safety" of 4, 5, or 6 or more, to 1.

Short-term burst tests are by no means the only test of pipe strength. In Kralastic pipe, as in other plastic pipe, they are much less important than the pressure that the pipe will withstand continuously.

Long-term effective tensile

At pressures substantially lower than they will stand in *short-term* burst tests, plastic pipes will show failure on long exposure—days or weeks—depending on the pressure. The relation of pressure to service life is as shown in *Fig. 2*. As the pressure is lowered, the life increases rapidly until at same pressure "P" the life becomes indefinitely long. If this pressure "P" is substituted in a suitable pipe formula (Barlow's or Lamé's—*Table 2*) and the equation is solved for the tensile constant, a figure will be obtained which gives the stress which the plastic material will support indefinitely without failure. A descriptive name for this stress is "long-term effective tensile."

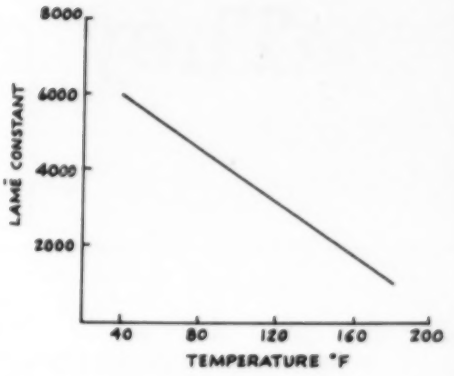
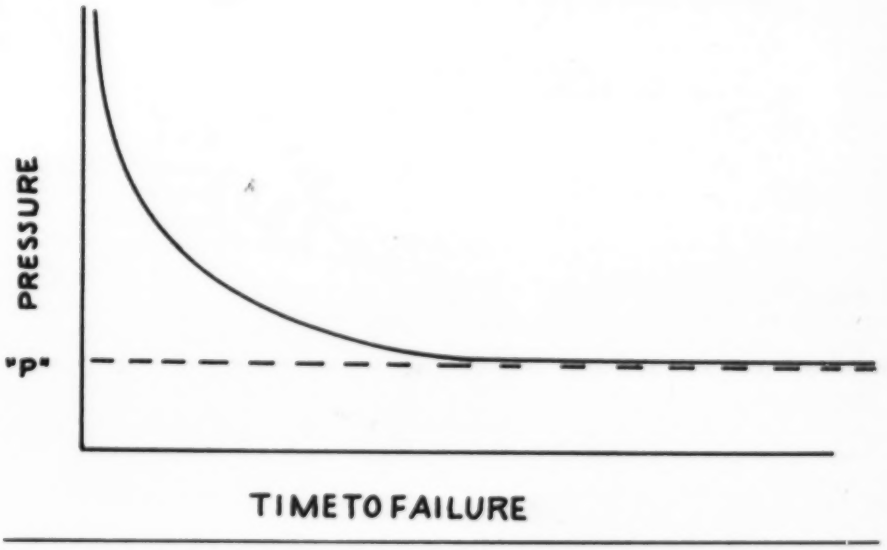


Fig. 1 (right). Typical burst values.
Fig. 2 (below). Relation of pressure to service life.



Use of the long-term effective tensile as the "tensile constant" in the Barlow or Lamé formula makes it possible to calculate the maximum pressure which any given size of pipe will maintain indefinitely.

The accurate determination of the correct value of the long-term effective tensile is a very time-consuming problem. The best figure now available for Kralastic is 2600 to 2800 psi at 73° F, or roughly 50% of the short-term burst tensile at the same temperature. This value is considerably above the corresponding figure for the other large-volume plastic pipe raw materials. Work is in progress on the more accurate determination of the long-term effective tensile of Kralastic.

The long-term effective tensile will decrease as temperature rises and so must be determined over the temperature range. The rate of drop follows the change in tensile constant as obtained in quick-burst tests. With this in mind, and with a safety factor of about 1.5 to 1, a "maximum safe working tensile" for Kralastic of 1000 psi at 100° F was recommended to the American Gas Association plastic pipe standard subcommittee. This value may be substituted for the "tensile constant" in the pipe formulas to calculate recommended maximum safe working pressure for any size of pipe. ■

TABLE 2. FORMULAS USED TO CALCULATE BURST

Barlow's Formula

$$\text{Burst} = \frac{2 \times \text{Tensile constant} \times \text{wall thickness}}{\text{Outside diameter}}$$

Lamé's Formula

$$\text{Burst} = \text{Tensile constant} \frac{(OD)^2 - (ID)^2}{(OD)^2 + (ID)^2}$$

OD = Outside diameter
ID = Inside diameter

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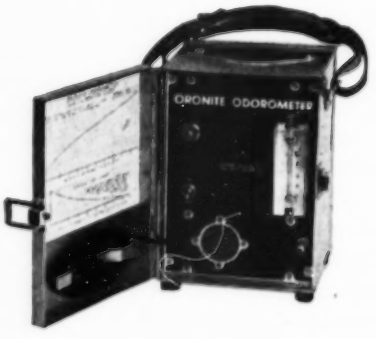

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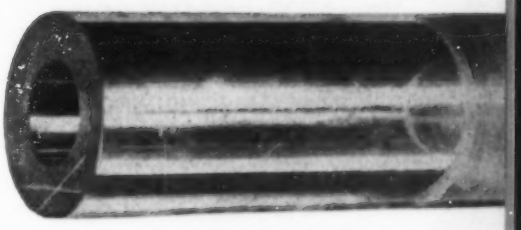

Plastic pipe subcommittee progressing toward establishment of standards

By **GUY CORFIELD** • Chairman

THE subcommittee on plastic pipe standards was formed approximately two years ago, and an organization meeting was held at that time. The general purpose was to develop technical standards that the gas industry could adopt for the purchase and use of plastic materials for underground gas piping.

The subcommittee consisted primarily of gas industry distribution engineers, together with plastics industry representatives from the pipe extruder or fabricator group. The present personnel* includes 12 gas industry members, two plastic industry representatives, and the executive vice president of the Society of the Plastics Industry as a conferee member.

A second meeting was held at Chicago, in April 1953, at the time of the distribution, motor vehicles and corrosion conference there. At that meeting it was decided to prepare and send to representative gas companies that were known to be using or to be interested in plastic pipe, a questionnaire designed to determine what kinds of plastic had been used and under what conditions of size, pressure, temperature, gas composition, soil conditions, etc.; or, if not already used, under what conditions might such use be desired. It was further planned that when this questionnaire was completed a summary would be made and given to the Society of the Plastics Industry, with the request that this society pass the summary on to its members and ask them to recommend what types and formulas of plastic could be used, and what dimensions within the various nominal sizes would be the most convenient and economic on which to standardize. It was thought that if these general objectives could be attained a better understanding would be developed between vendors and purchasers with respect to matching the properties of the materials against the desired and expected performance, and that possible confusion and inconvenience over a variety of pipe and fitting sizes and dimensions could be avoided.

The questionnaire was developed accordingly, and sent to 55 different companies in October 1953. Thirty-eight replies were received and summarized on a single sheet, and 75 copies of the summary were sent to the New York office of the Society of the Plastics Industry in January 1954. This summary indicated:

1. Four companies had adopted and use plastic tubing extensively.

2. Seven companies had used smaller quantities mainly for experimental purposes.

3. Of the 11 companies which had used plastic pipe, 10 used Tenite II (cellulose acetate butyrate). One company was using Kralastic (styrene-acrylonitrile) resin modified with Buna-N Rubber, and one company had tried both.

4. The most successful plastic-to-plastic connections were made by solvent-welded joints either bell and spigot type or with plastic couplings. For plastic-to-metal connections, the compression coupling appeared to be widely used.

5. No failures of the plastic pipe had been reported other than some that were mechanical or due to poor assembly.

6. The required sizes of plastic tubing were quite varied and there appeared to be no standard dimension which could serve in all cases.

7. About 70% of the trunk lines, 90% of the mains, and 90% of the services were operated at 60 psig or less.

8. At service pipe depth, a maximum of 93° F and a minimum of 10° F can be expected in some areas; for temperatures at main depths, the maximum is 85° F and the minimum is 10° F.

9. Installation temperatures showed extremes of 115° F to —30° F.

10. More than 50% of the companies replying used natural gas exclusively. The remainder used combinations of natural, manufactured and mixed gas. The constituents in the gas which may affect plastic pipe are fogging or scrubber oils (light hydrocarbon oils), odorants (organic sulfur compounds), and aromatic hydrocarbons. The odorants and aromatic hydrocarbons will be generally in vapor phase but may occasionally be in liquid phase.

11. No unusual soil constituents that would affect plastic pipe were noted.

While it was realized and known that there had been some usage of plastic pipe by the gas industry beyond that reported in the questionnaire, it was felt that the majority of use and experience had been covered.

A meeting of the subcommittee was held on March 8 and 9, 1954 in Chicago, to which were invited representatives from the plastic manufacturers group and the pipe and fitting extruders and fabricators group, for the purpose of discussing the summary of the questionnaire and the plastics industry's suggestions or recommendations for pipe materials and sizes.

*See accompanying box on page 76.

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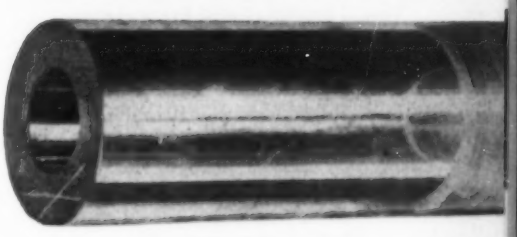

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*See accompanying box on page 76.

There was considerable discussion on all points, particularly with respect to pipe dimensions, and physical strength tests that could be used for specification, purchase and acceptance purposes. The results of these discussions produced the following recommendations:

1. The subcommittee wishes to emphasize that the word "plastic" is a generic term which applies to a distinct group of materials. Each of the numerous plastic materials has its own peculiar physical and chemical properties which must be considered before its applicability and serviceability for any end use can be determined. From the standpoint of describing a specific material, it is no more appropriate to refer to "plastic" pipe than it would be to refer to "metal" pipe.

2. The subcommittee wishes to state that although a few of the currently available materials have been used with success to date for the distribution of natural gas, the consumer should thoroughly investigate the qualifications of any and all kinds of plastic pipe that are under consideration for any application before the material is used.

3. The materials currently used to produce thermoplastic pipe for gas industry use underground are subject to attack by aromatic hydrocarbons. Therefore, the subcommittee cannot recommend the use of such pipe for the distribution of manufactured gas until further research and tests have been completed.

4. With respect to outside diameters, the subcommittee tentatively recommends that two pipe size schedules be offered by the plastic materials pipe manufacturers for use in the gas industry.

These schedules would be:

a. ASTM Standard Specification B-88 for copper pipe.

b. API Standard Specification 5L for iron line pipe.

5. The subcommittee is not prepared at this time to make wall thickness specifications. However, the Society of the Plastics Industry has been asked to submit minimum wall thickness recommendations for each kind of plastic pipe produced that will be adequate for the pipe to withstand mechanical handling, mechanical tamping of earth backfill and earth load within the installation and service temperature range indicated on the subcommittee's plastic pipe questionnaire summary report.

6. As regards wall thickness, the subcommittee recommends the use of either Barlows or Lamé's formula to calculate safe working strength values, whichever provides the lowest value for the bursting strength of the material. These formulas equate burst pressure, in psi, to tensile constant, wall thickness and diameter.

7. The tensile constant is the long time safe working unit stress. The Society of the Plastics Industry has been asked to submit allowable values for each of the various plastic materials, which would be applicable to pipe exposed to the temperature range noted in the questionnaire summary.

8. The subcommittee tentatively accepted an impact strength test method of the weight drop type. The Society of the Plastics Industry was requested to develop the details of this test method and conduct appropriate tests on each kind of plastic pipe at various temperatures and with the pipe under pressure.

The subcommittee chairman's report to its parent committee (the distribution committee of the operating section) at the operating section's spring conference in Montreal in April 1954 included the above recommendations, and stated:

"We are now awaiting the information requested from the Society of the Plastics Industry. When it is received it may be possible to furnish the gas industry with specific recommendations as to specifications for each type of plastic material, safe application and limitations, and wall thicknesses for desired operating conditions; and also to detail the test methods whereby the specifications may be checked. Such a program, and source of information, should, of course, be flexible enough to include new materials that may be developed. It is expected that considerable information will shortly be forthcoming from the research projects now underway at Battelle Memorial Institute, and elsewhere, designed to develop criteria for the appraisal of the various types of plastic as engineering materials.

"Meanwhile it is suggested that any company which desires to use a plastic material for underground piping make specific inquiry from the manufacturer of the base material as to its suitability for the proposed service, and also check the finished pipe and fittings by means of physical tests designed to reproduce the stresses that it will be subject to in the field. The plastic pipe standards subcommittee stands ready to furnish all the assistance that their present knowledge and facilities can provide."

The next meeting of the subcommittee was held at Cincinnati on Dec. 2, 1954. It was learned that the Battelle project is progressing satisfactorily but no conclusive data will be available in the near future. The thermoplastic pipe division of the Society of the Plastics Industry submitted recommendations for working stress and minimum wall thickness for several types of plastic pipe that were tentatively adopted by the subcommittee and will be appropriately publicized if and when approved.

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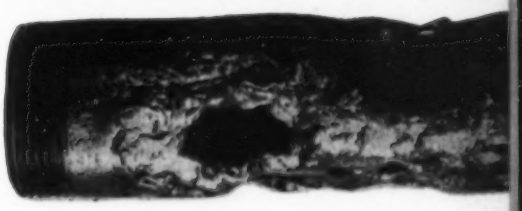

For cathodic protection power — Rectifiers or sacrificial anodes?

By RAY M. WAINWRIGHT, Associate Professor • University of Illinois

Part 1 ... General criteria

In any consideration of power sources for cathodic protection, optimum usefulness and optimum long-range economy are of fundamental importance. But aside from those situations where only sacrificial anodes or only rectifiers are feasible, there are situations where both may be used to advantage: here the decision may rest on economics alone. The author develops some cost concepts and shows how they may be applied to specific cases to help management select the system best suited to the conditions.

ONE of the controversial problems confronting present day corrosion engineers involves choosing between sacrificial anodes and rectifiers for sources of cathodic power. As a means of clarifying the issue, it should prove helpful to state the problem and then outline the methods of arriving at some practical economic solutions.

As the corrosion engineer well knows, cathodic protection has become one of his major ways of controlling corrosion, particularly on underground metal structures, or those in contact with sea water or various chemical solutions. He does this by impressing a potential across the metal-to-soil interface, of such polarity that the conventional electric current shall be directed from soil to metal at all times and over all portions of the surface. This procedure insures that all formerly anodic areas of the metal become cathodic, and that corrosion shall normally cease or be substantially reduced. A typical circuit representation of a cathodically protected structure might look as in *Fig. 1*.

In *Fig. 1*, the source of power is shown to be a box labeled "E". "E" might consist in practice of a d-c rectifier, powered from an a-c supply circuit, a motor, engine, or wind-driven d-c generator, a common battery, or a natural battery formed by using different metals at "G" and "P", as indicated in the figure. If "P" is steel and "G" is zinc, for example, an electromotance of around one-half volt is available to supply power, depending upon the chemical characteristics of the solution in which the metals are immersed, and on the state of the metal surfaces.

Other metal combinations produce various open-circuit voltages of between 0 and 1.5 volts or more, and thus cathodic protection power may be available from the so-called galvanic action of these when introduced into a chemical solution, such as a soil. Invariably, the metal at "G" must be anodic to be of use, and is consumed in the process, hence the name "sacrificial anode." "E" now represents no material object necessarily, but merely the source of potential inherent within the electrochemical processes.

The two most common materials currently being used for sacrificial anodes for cathodic protection power are zinc and magnesium. Both of these metals are sufficiently anodic to steel, lead, and copper structures to be of use in setting up the galvanic action. Theoretically aluminum should be even more useful; however, the erratic nature of surface films and oxide layers formed on aluminum anodes in soils and solutions have somewhat discouraged the use of aluminum. There is a possibility that research on environmental conditioning for aluminum may lead to increased use of this material in the future.

The open-circuit potential of zinc to steel may be around one-half volt, as has been previously stated, while magnesium-to-steel voltages may run nearer 1.00 volt or more. Under practical operating conditions the terminal voltages of these metals will run around 0.2 volts for the zinc and 0.6 volts for the magnesium. Such values of driving voltages may seem very low to many engineers not experienced in the field of cathodic protection, but the circuit resistances are also low by comparison, and currents may be appreciable even at these low voltage values.

If the anode material, at "G" in *Fig. 1*, develops insufficient voltage to the metal structure, or is of the same material as "P," it may be necessary to add additional driving voltage at "E." In this case the cathodic protection installation is powered usually by a com-

Readers of GAS will remember Mr. Wainwright's articles on the "Economics of Cathodic Protection" that appeared in the April and May 1954 issues.

mercial source of direct current, the rectifier operating from an a-c supply being the most common source.

The question now arises—which of these two methods, anodes or rectifiers, is of optimum usefulness or of optimum long range economy? This problem divides itself into three major classes, based on a usefulness criterion or long range economy, but not on direct cost factors:

Class A — Situations where rectifiers only are feasible.

Class B—Situations where either rectifiers or anodes are feasible.

Class C—Situations where anodes only are feasible.

Under Class B, where either type of cathodic protection power is feasible from an engineering standpoint, the question becomes—which is most economical from an equivalent annual cost viewpoint?

It should be recognized that answers to these questions are not absolute, but will vary from one part of the country to another, from one year to another, and from one set of circumstances to another. All we can hope to do here, therefore, is to point out the methods by which an engineer may arrive at his own answer for his own conditions at hand. In so doing it is necessary to rely on methods of engineering economic analysis as developed in previous articles[1,2] and on empirical data on corrosion control as gathered from many past and current field installations (see references).

Class A: The situations where a rectifier only would be used might include, say, a bare pipeline crossing a lake floor, where the cathodic protection of the underwater portions could be achieved only by impressing large amounts of current into the lake water from ground beds located near shore, and by collecting the current throughout the length of the underwater section. Here the extent of protection from the shore would be limited, since the pipe-to-water potentials would fall off away from the ground beds by some exponential curve of magnitudes, and extremely large blocks of direct current might be needed. Sacrificial anodes would likely be out of the question at such a location, unless they were installed at the time of line construction, and even then maintenance would be a problem.

In refinery piping and other locations where a great mass of metal is to be protected in one small geographic area, very large blocks of current may be required for cathodic protection. In such cases rectifiers are usually used. In situations involving extremely high resistance soils, rectifiers are again the only answer, since anodes will not develop sufficient voltage to force the required current through the circuit resistance. Other situations requiring rectifiers only might include applications in very low resistance mediums, such as sea water, where the anode life would be extremely short, and where high current densities are needed.

Class B: The situations where either rectifiers or anodes would serve, based on engineering requirements, form a very large class of applications of cathodic protection. In such circumstances the engineer must turn to economic analysis and install the type of cathodic protection power which will give him the cheapest immediate solution to his problem. Part II of this article will concern itself with examining the methods of deciding how to select the proper source of power based on these economic factors.

Class C: An example of a situation where anodes only are most desirable would be in the cathodic protection of welded or coupled gas or water distribution systems in cities where the system is of bare pipe, or where the system is of large diameter coated pipe. In this type of circumstance, the introduction of large blocks of direct current into the soil would result in interference with other bare metal structures in the soil. Rectifier installations, then, would create a hazard to foreign piping systems by virtue of the high current densities in the soil near the ground beds, and would be much less desirable than anodes as sources of power. The anode installation can be designed for small

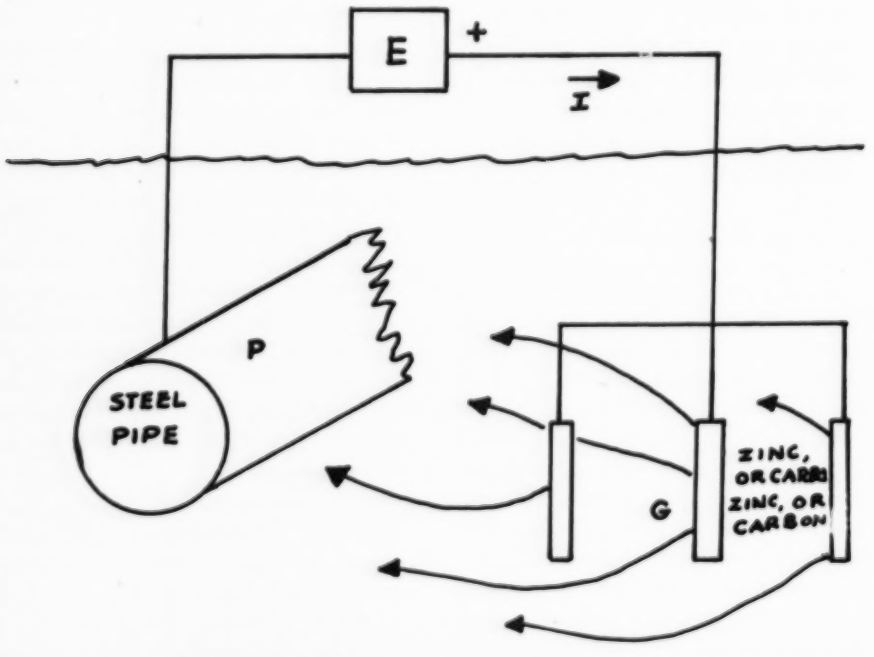

Fig. 1. A cathodically protected structure.

current densities in the soil, and for small and restricted electric field configurations which are within interference tolerances. In such an example, the economic picture is then overbalanced in favor of the anode by the damage claim possibilities resulting from use of rectifiers.

Anodes are also the best source of power in the absence of a-c power lines or of other direct current power sources, or in situations requiring small amounts of current in widely separated locations.

Part 2. Cost of cathodic protection power

Rectifier cost estimates will be taken from a recent unpublished study by the author covering between 40 and 50 rectifier installations on gas systems. While these may not exactly fit each corrosion engineer's situation, the figures will be typical for purposes of estimating and of this discussion. The study showed that the initial cost of a rectifier installation was between $1500 and $2000 for the range 40 to 60 amps. A good average seems to be $35 per amp of size, referred to direct current output. This average does not seem to vary appreciably over quite a range of output ratings—from 5 amp to 100 amp, in fact—although the tendency is for the smaller sizes to give larger figures and for the larger sizes to give smaller figures per ampere.

From the study referred to above and from a reference to various authorities on financial structures, the following factors are assumed for purposes of reducing installed costs to equivalent uniform annual costs:

Cost of money	0.07
Taxes and insurance	0.02
Fixed charges	0.09

Where cathodic protection rectifiers are supplied with power from foreign systems (company owning rectifier does not own a-c supply system), the following factors are typical:

Fixed charges	0.09
Depreciation	0.10
Power cost (a-c)	0.20
Operation and maintenance	0.11
Total	0.50

Where cathodic protection rectifiers are supplied with power on combination systems (company owning rectifier owns a-c supply system), the following factors are typical:

Fixed charges	0.09
Depreciation	0.10
Power cost (a-c)	0.10
Operation and maintenance	0.11
Total	0.40

For use in this study an average of 45% is taken as a good figure for reduction of installed rectifier costs to equivalent uniform annual costs. Using the value of $35 per amp of output as the cost of initial installation, we obtain,

$$\$35 \times 0.45 = \$15.75,$$

equivalent uniform annual cost per amp. A value of $16 per amp will therefore be used throughout this article for the usual range of rectifier sizes.

The next step will be to try to place the magnesium or zinc anodes on a similar basis. A 17-lb magnesium anode, with lead wire and backfill, will be used as a "standard anode" in order to obtain a basis for calculations. The cost of such an anode delivered on the job is assumed at $10 ($8.51 was an actual figure to a large Illinois user in 1954). This includes the wire lead and backfill. A comparable zinc anode putting out the same current over substantially the same life span would weigh approximately 30 lb, but costs (1954 market figures) about the same amount with lead wire and backfill. These costs obviously will vary considerably with location and quantity purchased, but will be assumed as stable for this discussion.

Based on experiences set forth in the literature on magnesium and zinc[3, 7], the standard anode as described above will put out approximately 0.1 amp for 10 years, its rate of consumption depending, of course, on soil and location conditions.

The installation cost of anodes will be assumed first at a figure of 1.00 times the delivered cost, giving a total installed cost of anodes of 2.00 times the delivered cost, or

$$\$10.00 \times 2.00 = \$20.00$$

per standard anode.

Based on the foregoing assumptions and computations, *Table 1* sets forth the equivalent uniform annual costs (EUAC) of the standard anodes based on various rates of electric current production. The life of the anode is assumed here to vary inversely as this current production. The EUAC is expressed in dollars per ampere of output, and is shown in column (7).

Fig. 2, curve (A), shows a plot of the EUAC of *Table 1*.

The direct current output in amperes

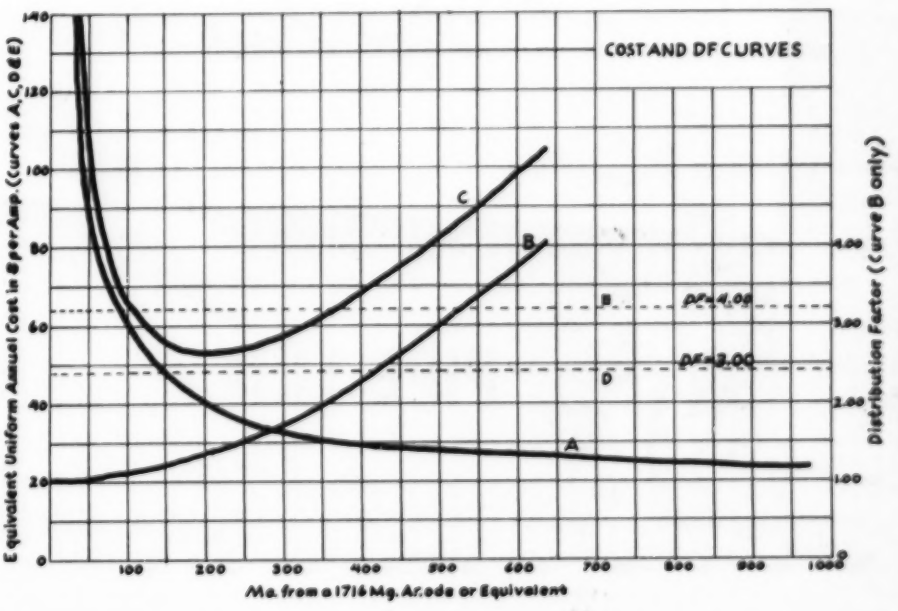

Fig. 2. Cost and distribution factor curves.

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Cathodic protection power ... Applying the curves

of a cathodic protection power source, however, is not entirely useful for cathodic protection purposes as a general rule. There are frequently large areas of over-protection near the power source which must be accepted in order to provide minimum protection levels farther from the source. This is more the case with rectifier sources where the currents are larger, but is also true for anode systems as well. The ratio of total amperes out of a cathodic protection source to the portion useful in maintaining cathodic protection is defined as the *distribution factor*, or DF. From field experience, rectifier distribution factors range from 3.00 to 5.00 or more[2, 5, 6]. Anode distribution factors may range from close to 1.00 to 3.00 or more depending upon the soil and relative locations, spacings, and other factors.

Evidently, in order to compare rectifier and anode costs it is necessary to convert the EUAC figures heretofore obtained per ampere of output to EUAC per ampere of current useful for cathodic protection. This can be accomplished by multiplying the EUAC figures from column (7) of *Table 1* by a set of distribution factors for anodes, and by multiplying the figure of $16 per ampere of output for rectifiers by distribution factors appropriate for the rectifier in question.

A possible curve of distribution factors for anodes is shown in *Fig. 2* as curve (B). It should be emphasized that this curve would be based on a particular spacing, location, and soil environment, and expresses the effectiveness of the anode with various current outputs. It is not easy to find values for such a curve, and the curve may change radically from one situation to another. However, for purposes of discussion the curve as shown will be used herein. By multiplying the values of curves (A) and (B) respectively, curve (C) is derived. Curve (C) shows the EUAC variation with ampere output of one anode, based on the effectiveness of that anode in providing cathodic protection. For purposes of comparison, the curves (D) and (E) are shown for rectifiers of distribution factors 3.00 and 4.00, respectively. These curves are shown as straight lines even though a more thorough analysis might show that the lines merely represent points from some curve of rectifier cost vs size.

There is probably some correlation between the abscissae of the curves of *Fig. 2* and the soil resistivity. For example, it might be possible to classify roughly the region from 0 to 100 ma. as representing soils of above 1500 ohm-cm. resistivity; that from 100 to 300 ma. as representing soils from 1500 ohm-cm to 500 ohm-cm, and that from 300 ma. up as representing soils from 0 to 500 ohm-cm. This would be on a magnesium anode scale. On a zinc scale the same current ranges would correlate with soil of above 500 ohm-cm, 500 to 150 ohm-cm, and from 0 to 150 ohm-cm, respectively.

As an illustration of the use of curve (C) of *Fig. 2*, take as an example a proposal to install anodes in a soil of roughly 1500 ohm-cm. In such a soil the standard zinc anode gives about 30 ma. of current and would cost around $140 per ampere of output; in the same case the magnesium anode costs $66 per ampere of output; and the rectifier of distribution factor 4.00 costs $64 per ampere of output. However, in a soil of 250 ohm-cm, the zinc anode gives about 200 ma. output, or a cost of $53 per ampere of output, while the magnesium anode gives around 600 ma. at a cost of $98 per ampere output, with the rectifier remaining at $64 per ampere output. In the first case the magnesium and the rectifier were similar in cost and much cheaper than the zinc. In the second case the zinc and the rectifier were similar in cost and much cheaper than the magnesium. Again it should be reiterated that these figures are presented to illustrate the method of analysis, rather than to present data which could be directly applied to a case at hand.

At this point the question might be asked: what is the effect of labor of installation on the curves for anodes? A study of the foregoing computations reveals that the effect would be to raise or lower curves (A) and (C), but to not change their shape substantially. One of the most critical factors in a decision between anodes and rectifiers, however, is the distribution factor curve. If this curve could be lowered for the larger anode output, one comes to a rather startling conclusion: anodes (17-lb magnesium, or 30-lb zinc) putting out from 100 to 300 ma. might be considerably cheaper than rectifiers, while in general these same sized anodes would be more expensive than rectifiers for outputs lower than 100 ma. This assumes that the compared rectifier has a DF of 4.00. Again, however, if the cost of the installed anode were to become from 3 to 4 times the delivered cost, the margin of advantage would be wiped out.

To summarize the conclusions so far:

The critical variants in the matter of choosing economically between rectifiers and anodes are: (a) the cost of anode installation labor, (b) the anode distribution factors, and (c) the rectifier distribution factors. An engineering designer for cathodic protection should pay particular attention to these factors in his special case to find which is more important. If the engineer attempts to reduce rectifier distribution factors by placing small units closer together, his cost of $16 per ampere of output will also increase because the rectifier support, the pole, the meter loop, the panel controls, cables, and other items contribute to a fixed cost which does not decrease at the same rate as the cost of the rectifier stacks and the operating costs. The anode distribution factors are influenced greatly by the geometry of

TABLE 1. EQUIVALENT UNIFORM ANNUAL COST PER AMP FOR THE STANDARD SACRIFICIAL ANODE

(17-lb magnesium or 30-lb zinc)

(1) Drain in ma.	(2) Fixed charges	(3) Oper. & Maint.	(4) Deprec. st. line	(5) Total factor	(6) Installed cost	(7) EUAC* per/amp.
33⅓	0.09	0.11	0.03	0.23	$20	$138
100	0.09	0.11	0.10	0.30	$20	$60
200	0.09	0.11	0.20	0.40	$20	$40
500	0.09	0.11	0.50	0.70	$20	$28
1000	0.09	0.11	1.00	1.20	$20	$24

*Equivalent uniform annual costs.

anode location, the state of the pipe coating, if any, and other factors such as soil resistivities. The installation costs may be reduced in some cases by larger installation programs enabling power diggers and power machinery to be used, and by standardization of installation procedures.

Some engineers have experimented with mass-produced rectifiers of small size which are located close together. No meter loop is used if the company also owns the electric supply system; meters are eliminated, and the rectifier case is made as simply as possible. The effect is to reduce the distribution factors below the usual 3.00 to 5.00, and thus obtain an economic advantage for the rectifier.

Part 3. Application to particular cases

In order to illustrate the methods of analysis discussed above, it seems desirable to discuss several typical cases of cathodic protection applied to underground systems. The following cases will be considered:

1. An isolated bare welded steel pipeline (10 miles of 12-in.).
2. An isolated well-coated welded steel line (10 miles of 12-in.).
3. An isolated bare line coupled every 20 ft (10 miles of 12-in.).
4. Hot-spot protection on a transmission line.
5. Bare distribution system for gas or water, with couplings.
6. Well-coated and welded distribution system (new).

Case 1. Usually rectifier spacings on such a bare electrically continuous pipeline will be experimentally determined and may vary considerably with the soil resistivity. Assume, for example, the cathodic protection of the 10-mile section in a fairly homogeneous soil of about 1500 ohm-cm resistivity. Assume that 1 ma./sq ft has been found to be a proper current density for complete protection. This implies that a total input current of

$$10 \times 5280 \times 1 \times \eta \times 0.001 = 166$$

amp will be required to protect. If a distribution factor of 3.5 is assumed, the total current requirement from a rectifier would be

$$166 \times 3.5 = 581 \text{ amp.}$$

This represents an EUAC of

$$581 \times \$16.00 = \$9296 \text{ per year,}$$

providing that 10 to 15 rectifiers were used over the 10-mile section.

As a comparison, assume that 17-lb magnesium anodes (zinc might be more costly here due to lack of current output) will put out an average of 100 ma. for 10 years in this soil. For frequent anode spacings and reasonable geometric configurations, a DF of 1.10 is assumed; therefore, each anode will provide for

$$100/1.10 = 91 \text{ sq ft}$$

of metal surface, or an amount of line, $91/(1 \times \eta) = 29$ lineal ft approximately. One anode for each 29 lineal ft of pipe should then give adequate protection providing that the assumptions made on distribution factor are now compatible with this spacing. The installation will involve

$$5280/29 = 182 \text{ anodes per mile}$$

to give a total of 1820 anodes for the 10-mile section, or a total current of 182 amp. The EUAC for this anode installation would be

$$182 \times \$66 = \$12{,}012 \text{ for the line.}$$

Intangibles

Evidently, in the case assumed, and with the various assumptions which have been made, the rectifier installation is the cheaper by several thousands of dollars per year. However, there are a number of intangibles that should be considered. For the case just outlined, suppose that the required level of protection were discovered to be 2 ma./sq ft instead of the 1 ma./sq ft assumed. The rectifier would have also provided this level over, say, 60 to 80% of the former coverage, because of the large distribution factor, while the anodes would have provided this level over none of the distance. Other intangibles include right-of-way advantages of one method of protection over the other; greater continuity of service from anodes over rectifiers powered from a-c lines; and various other factors applying to a specific case.

Case 2. There is no particular difference economically between the bare steel case and the coated steel case except for the generally lowered current requirements in the coated situation. Both rectifiers and anodes will be placed farther apart and the costs should be reduced by a factor of 1/20 at least, perhaps even by 1/100. In soils of high resistance the anodes may not supply sufficient driving voltage, since the circuit resistance is higher due to the coating. In practical instances the cost of either rectifiers or anodes is likely to be in the same order of magnitude, providing that the anodes can be used at all. The resistivity of the soil must be very low to utilize zinc economically in this case. Magnesium ribbon may be of advantage in high resistance soils, otherwise rectifiers would be used.

Case 3. The bare line with insulating couplings is probably no longer constructed, but many old lines on which protection is needed are of this type. Here the advantage of cathodic protection over reconditioning of the pipe may be less, but it may also pay out with ratios of cost of one-half to one-fifth of the cost of the reconditioning, both reduced to the EUAC basis.

Couplings

If a rectifier is used the couplings must be made electrically continuous, or bonded. Experience shows that the current cost of bonding on transmission lines in rural regions may range from $2 to $15 per bond. For purposes of discussion it will be assumed as $6 per coupling. The cost of a mile of bonding is then:

$$5280/20 \times 6.00 = \$1584 \text{ per mile.}$$

To reduce bonding costs to an EUAC basis the following factor is derived:

Fixed charges	0.09
Depreciation	0.02
Total	0.11

The cost of bonding is then

$$\$1584 \times 0.11 = \$174.24 \text{ per mile,}$$

annually; for 10 miles of line the cost will be approximately $1750 annually. This figure must be added to the EUAC for rectifier protection from *Case 1:*

$$\$9296 + \$1750 = \$11{,}046 \text{ per year.}$$

Only a portion of this cost must be added to the anode installation, however, since the bonding bell-holes may be used for anode connections. If it is

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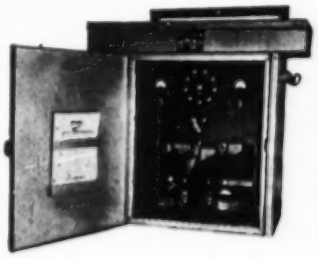

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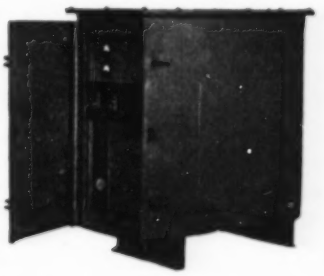

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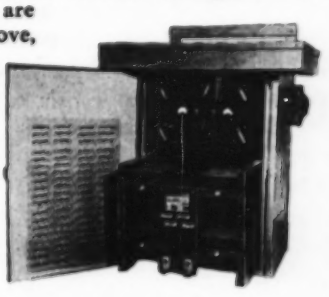

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assumed that $750 may be saved in this manner, the comparable cost of anodes would be
$12,012 + $1000 = $13,012 per year.

It is interesting to compare at this point the cost of protection vs the cost of reconditioning. Assuming that reconditioning costs $20,000 per mile for 12-in. line in the type of terrain of the example, the annual charges for a 10-mile section would be
$20,000 × 10 × 0.11 = $22,000 per year. The cost of cathodic protection was evidently about half of the cost of reconditioning in the example cited.

Case 4. "Hot-spot" protection refers to transmission lines on which cathodic protection is needed at stream beds, irrigation ditch crossings, alkali flats, or other areas of extremely local corrosion attack. It is assumed that the line is generally free from corrosion except for the aforementioned locations.

Cost of power

Since the cost of power from rectifiers and anodes is usually in the same order of magnitude, the problem of hot-spot protection reduces to determining whether the section is long enough to bear the total charges on a small rectifier, compared to the normal anode design for the area in question. For a 100-ft section of 12-in. line needing a total of 300 ma. of current, for example, three or four anodes might do the job at an EUAC of from $20 to $25 per year. The smallest rectifier installation practicable would likely cost $150 installed, giving an EUAC of around $60 to $70 per year.

For such short section, therefore, the anode seems to be a better solution. Intangibles would include the partial protection given by the rectifier over adjacent line, but not provided by the anode system. If the hot-spot is of sufficient length, then, the problem becomes similar to that of the long transmission line, and decisions must be made on a similar basis.

Where it has been decided to protect the hot-spot by sacrificial anodes, then comes the question: should zinc or magnesium be used? The costs of these two have been shown to be of comparable magnitude for a given current output. However, the environment fixes the output and may also influence the choice of material. Thus zinc would probably be a first choice for very low resistance soils, while either could be used in medium resistance soils, and magnesium would likely be chosen for high resistance locations.

Case 5. The cathodic protection of a bare gas or water distribution system with couplings becomes a very expensive solution to the corrosion problem. Rectifiers are usually ruled out because of the possibility of excessive damage claims resulting from deterioration of other bare piping systems not connected to the protection system. On the other hand, anode installation costs may skyrocket if the lines are under pavement. Protection of such systems is usually undertaken on a hot-spot basis unless all systems can be protected with one cathodic protection system, eliminating the possibility of damage to foreign piping. Many companies have formed a policy of installing an anode at each leak that develops on the system, and where the risk from leaks is high, this procedure seems sound. Bonding of bare distribution lines is usually not done unless a rectifier can be justified for some particular isolated section of the system.

Unprotected coupling

Some companies install one or more anodes on a joint of pipe, and leave the couplings unbonded. This may halt corrosion on the joints, but may also leave the coupling itself unprotected.

Case 6. If a new well-coated piping system is carefully insulated from all other bare and foreign systems, either rectifiers or anodes may be used. If the system under consideration is of small sized pipe, current densities will be low in the soil, rectifier distribution factors may be down below 3.00, and the economic picture seems to favor the rectifier. This is particularly true on small distribution systems where one rectifier may be used to protect the town plus a transmission lateral as well.

Again anodes may also be used with only slight economic disadvantages. Intangibles favoring the anode include the difficulties encountered when rectifier ground beds are located within the distribution system and near foreign piping. At this location current densities are highest and some interference is probable. The elimination of this interference involves, usually, partial protection of some of the foreign pipe, with a corresponding reduction in distribution factor for the rectifier installation.

4. Conclusions

When direct economic calculations plus intangibles are taken into consideration, the usual solutions to the problem of rectifiers vs anodes may be listed as follows:

Rectifiers. Used for cathodic protection of gas, oil, and water transmission line in all resistivities of soil or solutions; for protection of ship hulls and other metallic structures in soils and solutions. Not used where stray currents created in the soil or solution would be hazardous. Used in refineries, and in high resistance soils.

Sacrificial anodes. Used for bare and coated distribution systems in cities; for hot-spots in transmission lines; for cathodic protection where no a-c power supplies are available; and for use where the inherent low distribution factor gives the anodes an economic advantage. Zinc may be more advantageous in very low resistance soils or solutions; magnesium in soils of moderate resistance.

Ratio

In situations where either may be used engineeringwise, the distribution factor or ratio of power source output to usable output is a most important factor. This ratio is high for rectifiers and low for anodes as a rule. In a situation where the rectifier distribution factor is 4.00, and the anode distribution factor is 1.10, there should be very little economic advantage of one type of power source over the other, for moderate anode outputs. ■

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This meter can be read two ways

Meter posed in front of mirror to show second index on back of meter. Spur gears drive shaft from standard index to back index.

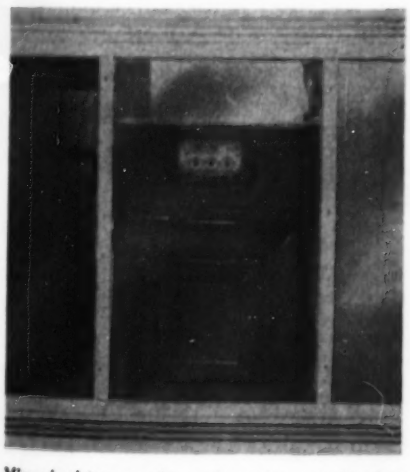
TODAY, with a high percentage of wives working, every gas serviceman knows how hard it is to find the "lady of the house" in. As suburbs become more isolated, residents are away from home for longer periods of time to shop or run errands. This means meter readers, unable to get inside, must make more "skip" readings than ever before. It is no wonder that gas companies have given serious consideration to the problem of installing meters that may be read without entering homes.

New houses in the Long Island area of New York are designed with the gas meter inside and the electric meter outside. The majority of home-owners would prefer not to be disturbed by the meter reader at all. However, gas companies that operate in areas of severe cold are reluctant to make outside installations for metering manufactured gas because of condensates and freezing. With the use of natural gas, these risks are somewhat lessened, but there still remain inaccuracies because of temperature extremes. And the cost of moving all existing gas meters out of doors would be prohibitive—or at least uneconomical.

One of the new devices that make possible outside reading of inside meters is the dual index meter. Designed by the Long Island Lighting Co. for its own use, this meter has a second register that is installed in the back of the meter and gear-driven from the regular index shaft (to give normal rotation of both indexes). Identical readings can be taken from the front and back of the meter. Tests before and after installation of the second standard index show no readable increase in differential across the meter at the rated capacity (150 cut ft per hr).

One main advantage of this approach is that the cost per meter is about one-fifth that of remote register devices. The meter set can be right or left hand, as required, without an extra fitting, and it may be placed at a normal distance from a window or glass block. Existing meter sets can be transferred more easily to new locations in front of windows. Within the premises, index test and prover dials are directly available to servicemen so that appliance burner settings and inside leaks may be checked without the use of mirrors or auxiliary lighting at night. The second index does not interfere with the repair of the meter, adding only the negligible cost of resetting to the repair bill.

Although still experimental, the dual index meter presents a practical approach to the problem of making inside gas meters readable from outside.



View looking in through cellar window at second index on back of meter.

Dual index meter in position at cellar window. Meter faces cellar.

Adapted from a story by C. M. Harris of Long Island Lighting Co., Mineola, which appeared in *The Flow Line*, published by Rockwell Manufacturing Co., Pittsburgh.

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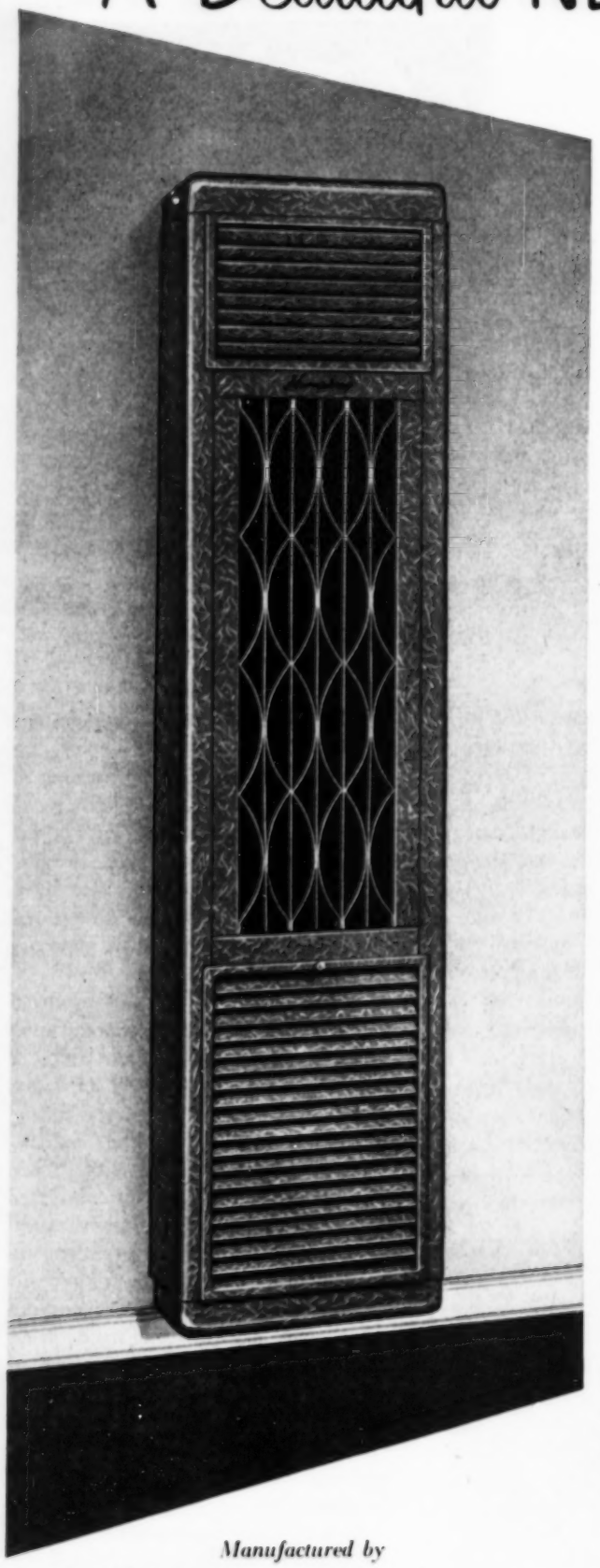

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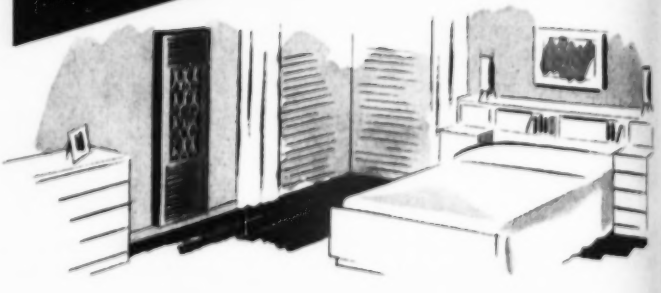

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"The critical question arises not when a meter is in the 14-year age bracket (meter to be repaired) nor when in the 28-year age bracket (meter not to be repaired), but when it is in the 21-year age bracket."

Economics of planned meter retirement programs

By G. K. BACHMANN, General Superintendent of Meters
Public Service Electric & Gas Co., Newark, N. J.

"Four points of economic search"

This article is adapted from the prize-winning essay in the contest conducted by Rockwell Manufacturing Co. on planned meter retirement programs. (See February GAS, p. 103.)

REAL satisfaction to the gas company and its management in a planned meter retirement program that allows new meter replacement purchases can exist only if the program is based on economic study and fact. Such study must include aggregate information on at least sample groups of meters in various age categories, as well as intimate knowledge of the construction and performance of the various types of meters in service.

Under certain circumstances it is possible that meters of advanced age may be mechanically unsound, or even unsafe to the consumer. In this instance the problem is essentially one of operation and does not properly fall under the subject of this essay. Of course, unsound operating meter conditions do have economic connotations but the subject under study is not ordinarily expanded to include such considerations.

Four points of economic search must be covered in a comprehensive study of meter economics. These are:

1. Depreciation.
2. Cost of removing from service and testing.
3. Maintenance cost.
4. Loss in revenue due to inaccuracy.

Fig. 1 and *Fig. 2* give a graphical description of cumulative life meter cost. Note that the conventional chart *(Fig. 1)* has smooth curves that result from group statistics of meter maintenance involving large numbers of meters. *Fig. 2*, with sharply reversing curves, indicates a sample periodic maintenance cost history of an individual meter, which is an illuminating consideration in this study.

Although largely based on tinplate steel meter considerations and performance, the methods and findings of the study are fundamental to studies of meter obsolescence regardless of type.

Generalities of meter life

Each of the four points of economic search is important. None should be written off with a preliminary conclusion that it is unimportant in a study

(Continued on page 90)

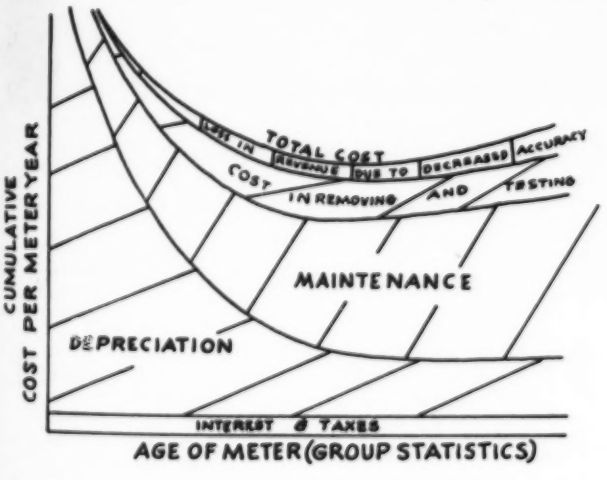

Fig. 1. Graphical description of cumulative life meter cost based on group statistics.

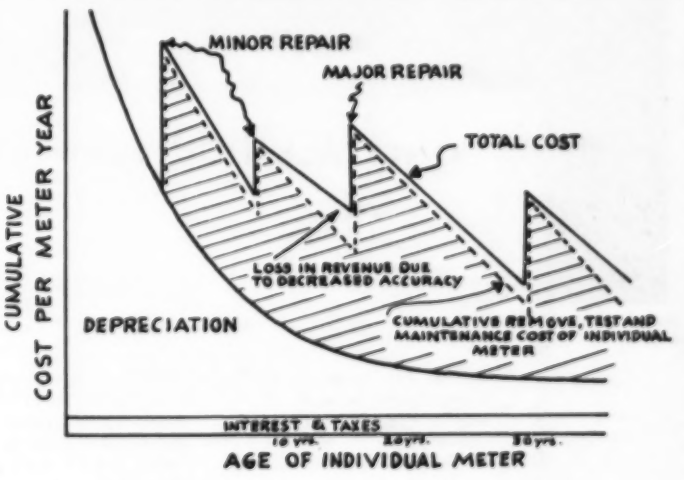

Fig. 2. Sample periodic maintenance cost history of an individual meter.

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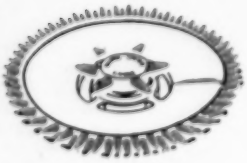
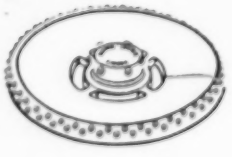
ONLY ALLTROL® BURNERS GIVE THRIFTY MEASURED HEAT



Instant full flame... brings foods to cooking temperature in shortest time.



"Click"... convenient Low Frying heat... provides perfect widespread low heat for "most used" frying operations.

"Click"... efficient Center Simmer... maintains boiling in any covered utensil.

"Click"... gentle "Keep-Warm" heat... keeps foods perfect for serving without further cooking.

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Coast-to-coast the story's always the same—

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Only gas ranges with Center Simmer Burners can give these 6 user-benefits. And when you demonstrate these advantages—you, too, will find your range sales shooting upward—fast!

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6 benefits your customers buy

- **COOLEST COOKING**—The measured heat of Alltrol Center Simmer Burners keeps kitchens up to 9° cooler. Cooks the food—not the cook!
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- **HANDY KEEP-WARM HEAT**—Tiny pre-set flames keep food and beverages perfect for serving without further cooking!
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- **GREATER CONVENIENCE**—No "matching" of pans with burners—use any utensil on any burner! And you can set the right heat by sight or by sound.
- **THRIFTIER COOKING**—Save up to 39% on fuel costs alone! It's an important saving—for 80% of home cooking is done on the top burners.

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of meter economic life. The four points may have hidden values, which only application of factual data will bring out.

Taking the four points individually, we may note the following:

1. The depreciation method employed by the gas company must be applied in the meter study. Although the individual may theorize, for instance, that a sinking-fund method gives a true picture of depreciation cost, it is useless to use the sinking-fund method if the accounting department prefers straight line or some other method.

2 & 3. In general, a major reduction of removal, test and repair costs, which is made possible only by extending the meter-change period, has not been accomplished in the past through excellence of meter construction and repairs in areas where manufactured gas was prevalent, but is now possible and probable with the advent of natural gas. In economic study today we must rely on the performance record of meters in natural gas areas, although the particular gas property under study has only a manufactured gas history. To do otherwise would be to ignore the tremendous changes in our industry. What to expect meterwise after conversion to natural gas has been given great publicity in gas association meetings.

4. Loss in revenue caused by inaccuracy is a matter of great importance when considered in connection with old-style meters, which lack durability in meter materials, and any meters subjected to chemical effects of manufactured gas.

Today, customer refunds made after meters are removed and intested with a fast result are of dubious value as supporting evidence that billing overcollections from these customers were actually made.

Customer refunds

No overall economic study figures based on past performance of a gas company are given here. These studies, combining the four points of economic search, are to be found in American Gas Association Proceedings of recent years. But they have a limited value today, because the conclusions drawn from large-volume statistical data presented were based on continuation of relatively stable gas conditions, i.e., the sending out of manufactured gas. However, with the use of these studies as background material, we may make certain observations in order to obtain worthwhile conclusions to present meter economic problems.

21-year life

A review of a well-known study of optimum meter life presented by David Allen of the Washington (D. C.) Gas Light Co. in 1938 reveals an observation that has great value today. Careful reading of that paper, which concludes that meter life should average about 21 years, brings to light the fact that a change in the type of meter purchased had occurred 21 years before the study was begun. Reference is made in the following section to past meter design changes of major consequence.

Current peculiarities

A STUDY of economic meter life must, of course, be attuned to present conditions. Today, gas companies are for the most part either veteran distributors of natural of mixed gas or newcomers in the distribution of natural or mixed gas, with consequent disturbed meter-proof problems. The present cost of a rediaphragm repair (largely needed to recondition meters under a gas conversion program, but also occasionally required as a result of failure under natural gas operation), together with the expected life of such reconditioned meters on the one hand, must be balanced against the cost of a new meter and its life before extensive repairs are needed, on the other hand. The present range of meter life as practiced by most gas companies varies, using approximate figures, from a minimum average life of 21 years to a maximum of 35 years or more. These age figures are multiples of seven years, a common periodic change period.

Change period

Gas companies either now have or are looking forward to establishing a change period of at least 10 years, and all efforts should be directed to a realizition of such a goal, for, as mentioned previously, only thus can a major reduction in metering cost be effected. In the case of companies that have undergone a conversion, the meter installed in service today is the one that must be depended upon at the end of the average seven-year change period to give a performance, largely gauged by intest proof, of sufficient average excellence to allow application to the public service commission for the 10-year-change period. In the case of veteran natural gas companies, application for longer periods of service is expected.

We now reach the principal question: Is it economically realistic, in view of our expressed goal, to make extensive repairs on meters in service 14, 21, 28, and 35 years?* This question does not have a simple answer.

Major changes

Major changes occurred in gas meter design in the middle 1920's. These resulted partly from the consolidation of a number of relatively small meter manufacturing enterprises into what became the largest manufacturing company of that era, with consequent standardization of meter design.

Many meters purchased before 1925, averaging perhaps 35 years of age, are presently being repaired by many gas companies, but it must be a policy of expediency rather than economics that allows such a practice to be pursued.

*Here again the service periods used are multiples of seven years. These multiples are not meant for specific meter age, but are meant to apply to meters in the same general age, whether multiples of a periodic change period or not.

(Continued on page 94)

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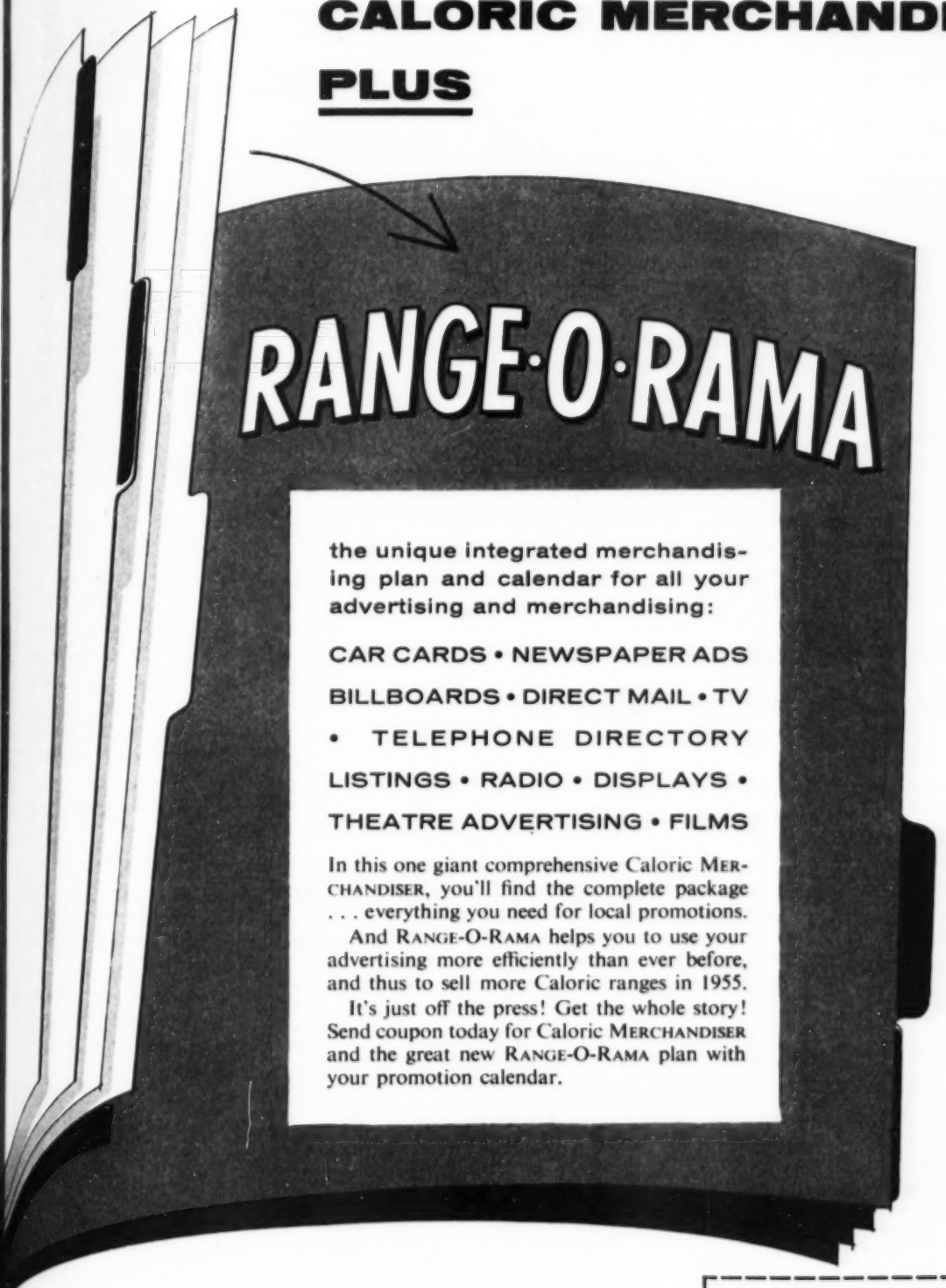

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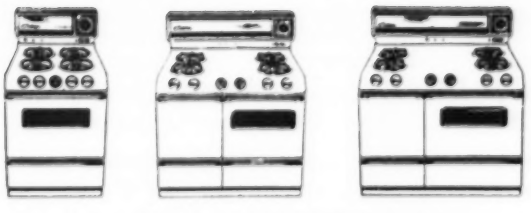

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Meter retirement . . . Local experience key to question of tinplate or hardcase meters.

Features of these meters of the 5-lt. size such as lead stuffing boxes, light-gauge flag rods, narrow flag-to-rod joint, soft-metal carriage brackets, 8-in. small-capacity diaphragm, absence of the brass bushing in white metal valve cover arms, non-riveted screws, long side pipes, putty index glass, click-type reverse stop, etc., are money losers. Furthermore, their capacity is either low, in the vicinity of 90 cfh, or too high for the quality of construction, as in the case of the old style 5A meter with its hollow wearing and oversized valve covers. Failure to replace these meters with ones of modern design can only result from failure to face the problem.

Much more can be said in defense of repairing meters purchased in the late 1920's and thereafter. These meters have none of the faults enumerated above for meters of earlier vintage.

Tinplate steel meters of present modern design, although fundamentally the same as those mentioned in the previous paragraph, have, of course, a number of important improvements, such as overcast solid brass valve cover arms, the presently preferred 4-circle index, improved index test dial, 100% solder seal index glass, etc. In a few of its features, such as the use of 4a tinplate in place of the present 2a, and the heavy metal 5B-type valve cover in place of the present 5B lighter metal or 5B bakelite cover originally designed during war emergencies, the construction of the older meter is (or was) slightly superior.

Minor repairs

The so-called "disposable" meter is making its appearance on the market at this time. "Disposable" is really a misnomer, for this meter is designed to take minor repairs only. Too little is known of the price and performance of these meters at this time to include them in a study of meter economics.

Today, hardcase meters in either aluminum or cast iron have greatly improved design, together with long-wearing materials in moving parts. The probable life of these meters is almost unlimited, except possibly for obsolescence brought on by future improvements. There is a difference of opinion among gas operators as to whether the performance of hardcase meters, using generally higher crank speeds for equal flow and various style of diaphragms, is as good as, equal to, or better than that of tinplate meters. Regardless of this difference in thinking, a complete survey of economics of replacing meters from service must include consideration of the hardcase meters, with their particular adaptability to outdoor sets. Local performance experience is the key to the answer to the relative desirability of tinplate or hardcase meters.

Volumes involved

The consideration of whether to replace soundly designed meters purchased within the past 14 to 28 years is important because of the great volume of meters involved. In this connection, the following questions should be answered:

1. Has physical deterioration of the 21-year-old meter been avoided to an appreciable extent?

(The average situation is about as follows, although local conditions must be known for the individual situation. Meter age shown is an approximate figure.)

14 Years Age	21 Years Age	28 Years Age
Yes	Probably	No

2. What is the rediaphragm cost compared to the purchase price of a new meter? (Average situation.)

14 Years Age	21 Years Age	28 Years Age
60%	65%	70%

3. In units of the goal of a 10-year age period, what is the expected life of the rediaphragmed meter, with sound metal skeleton? (Average situation.)

14 Years Age	21 Years Age	28 Years Age
20 Years +	10 or 20 years depending upon meter condition and quality of repair.	10 Years

The answers above indicate that the *critical* question arises not when a meter is in the 14-year-age bracket (meter to be repaired) nor when in the 28-year-age bracket (meter not to be repaired), but when it is in the 21-year-age bracket. If a gas company is so fortunate as to have plant and labor conditions allowing a rediaphragm repair at 5 to 10% less than the estimated 65% of cost of a new meter, it should repair the 21-year-old meter. This is because, at a repair cost equaling 65% of the cost of a new meter, the maintenance cost of the repaired meter per year of operation for another 20 years will necessarily be quite close to the cost per year of operation, including depreciation and maintenance, of a new meter for its first 30 years before rediaphragm repairs are needed (see *Table 1*).

Certainly it is fair enough under today's relatively clean gas conditions, resulting from a preponderance of natural gas, to conclude that if a repaired 21-year-old meter will carry on for 20 years without further extensive repairs, a new meter of current substantial construction will carry on for its first 30 years without extensive repairs.

Summary and conclusion

ECONOMIC study as outlined herein leads us to a planned schedule of meter retirement and replacement as follows:

1. World War I era meters purchased as late as 1925 shall be retired without question.

2. Meters purchased since 1926 shall be discriminately treated as follows:

A. 14-year-age bracket—repair (sound metal stipulated)

B. 28-year-age bracket—retire and replace

TABLE 1. COST COMPARISONS

Repaired Meter	New Meter	
Repair — $10.50	Cost — $16 (tinplate)	$14-$18 (hardcase)
Extended life — 20 years	Life without major repair — 30 years	(Make savings allowance for greater advantage in outdoor sets.)
Cost/year — $0.52	Cost/year — $0.53	

Solid aluminum alloy tank! Cannot produce rusty-red water!
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Planned meter retirement program

C. 21-year-age bracket—
(sound metal stipulated)

1. If favorable local conditions of plant, labor conditions, and volume of repair (or a long term favorable repair contract) exist, so that the rediaphragm cost is 55%-60% of a new meter cost, repair these meters.

2. If the rediaphragm cost is 65% or more of the new meter cost, retire and replace with new meters.

Any time new equipment can be purchased and operated at a cost no higher than that of depreciated equipment, the desirable method of operating is to purchase new equipment, which realistically maintains the book value of property. This is a desirable economic practice that applies not only to meters but to any property operated by a business concern. This economic practice is one reason the economy in America has progressed faster than in many other countries of the old world. In times of economic stress, such as war, the operator of relatively new equipment is in an infinitely better position with regard to survival than the operator of depreciated equipment.

Money conditions

There are times when money market conditions make it undesirable to issue bonds or other securities at a high interest-bearing rate in large volume. In such instances, the replacement of meters, using additional capital, may be delayed by financial considerations in favor of carrying meter repairs as an operating expense. However, the raising of capital is essentially an extraneous matter in meter economics.

The time eventually arrives in the life of a meter when an extensive necessary repair, designed to prolong the life of the meter a period of years, results in an annual maintenance cost over this prolonged period of years approximately equal to the annual maintenance and depreciation cost of a new meter, which will not need extensive repairs for a period of years well in excess of the prolongment of the life of the repaired meter. It is then that the prudent public utility operator, who *plans* to keep his meter plant in the best economic condition, grasps this opportunity to replace the old meter with a new meter at no added overall cost. ■

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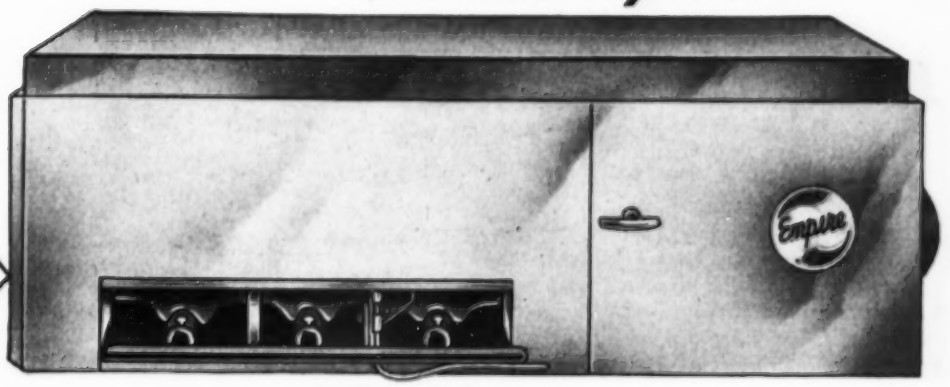

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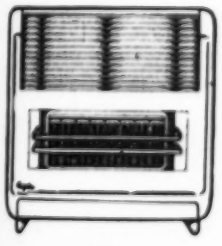
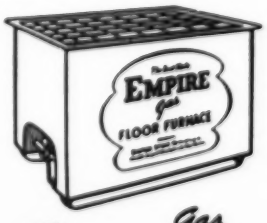


Gas CIRCULATOR HEATER



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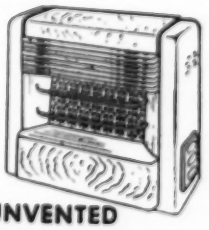

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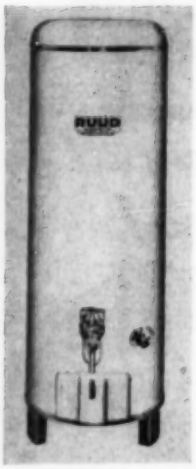


Aluminum alloy tanks, designed to prevent red tank rust are featured in Ruud's new residential gas water heaters.

The four new units are identified as Ruud Alcoa alloy models. They have performance ratings of 49, 60, 76, and 104 gals.

The Ruud Alcoa alloy series offers, on an optional basis, the same Duo-Temp feature provided in other models. Either at the time of installation or later, the water heaters may be equipped for two-temperature operation.

Ruud Manufacturing Co.

■

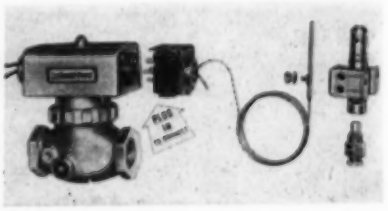
2 Plastic Pipe

Rigid plastic pipe in standard pipe sizes from ¼ to 2 in. is now being produced by Easton Plastic Products Co. Extremely close tolerances on pipe walls with uniformity of quality are features.

The pipe can be threaded and is used with rigid PVC fittings. The pipe is made from B. F. Goodrich Geon material in both normal and high impact varieties. Easton is presently developing 3- and 4-in. pipe and anticipates production of 6- to 8-in. sizes at a later date.

Easton Plastic Products Co. Inc.

■



3 Combination Valve

White-Rodgers has introduced a new gas valve combination for use in combination with a plug-in type automatic gas pilot. Being unassembled, a small inventory of valves and pilot sub-assemblies will provide combinations to fill practically any gas-fired requirement.

In addition to the plug-in feature, the new pilots combine a snap-action switch and a powerful mercury-actuated thermal element. They are specially designed to operate through a wide range of gas pressures and are for use on both line and low voltage.

Available in both automatic reset types, the valves come unassembled in three basic sub-assemblies: switch and thermal element, pilot burner and bracket, and orifice fitting.

White-Rodgers Electric Co.

■

4 Spray Coating

A new spray coating for metal equipment that combines protection from corrosion with a moderate degree of insulation is being produced by the Tar Products division of Koppers.

Black in color, the new coating is made of processed coal tar pitch mineral filler, solvent, and granulated cork. Requiring no primer, one application of the coating produces a protective covering up to ½ in. thickness.

Such combined protection is best suited for oil storage tanks, asphalt storage tanks, any metal tank whose contents are kept at temperatures up to 150°F, chemical plants or equipment, corrugated steel sidings, and heating and ventilating ducts.

Koppers Co. Inc.

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5 Boiler-Chiller

Year-round airconditioning is offered in Hydrotherm's "wet package," which combines a gas-fired boiler with a completely assembled water chiller. Occupying a floor space of 18 in. by 26 in. and standing 54 in. high, the unit has heating capacities ranging from 288 to 480 sq ft of installed radiation and cool-

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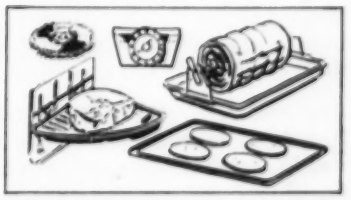
Extra gadgets and appliances become unnecessary when you have a new Florence "Governess" Range. Any pot is a deep-fat fryer, any pan is a controlled-heat skillet!



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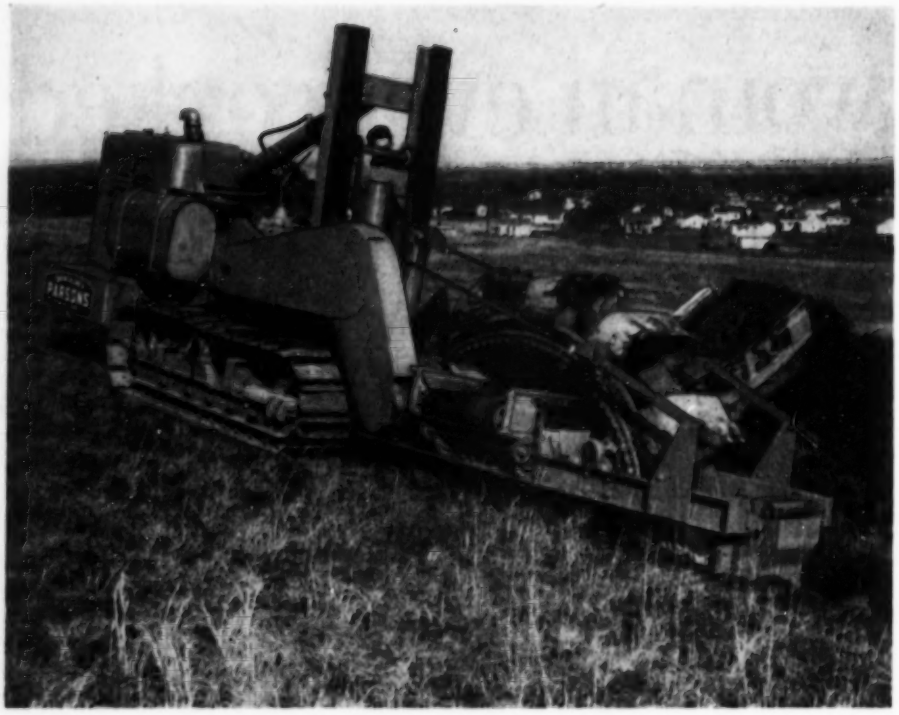
Florence Stove Company
Merchandise Mart • Chicago 54



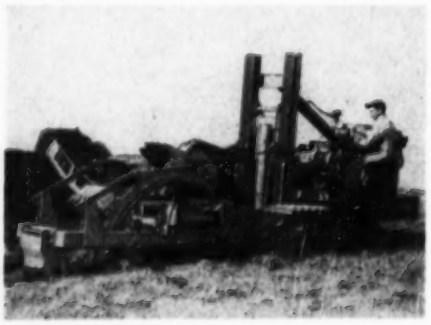
Opens 25 feet of trench per minute

On transmission lines between cities, and on distribution and service lines in town, Parsons 150 wheel-type Trenchliner combines big production capacity with precision grading accuracy. It digs 16 to 26 inches wide, at depths to 5¾ feet. 30 digging feeds up to 25 feet per minute assure maximum trench production at every width, depth, and in all soil conditions.

Specified grades are easy to maintain. A hydraulic ram on vertical mast raises and lowers the digging wheel with fractional inch accuracy — giving minute depth adjustments. (A separate hydraulic ram tilts the mast — balances weight of the wheel forward on machine for traveling or trailer-loading.)

To suit dry or wet digging conditions, quick-change buckets on the heavy-duty digging wheel have gumbo lips, or self-sharpening, reversible "Tap-In" teeth. Buckets are all cast-steel — and are available with solid or tine backs.

Hinged crumber sweeps trench bottom clean, ready for pipe. Shiftable reversible belt conveyor, 24 inches wide, places the spoil bank on either side of the trench.



This Parsons 150 Trenchliner also has standard tractor crawlers with 16-inch treads and lug-type shoes (street pads optional). It is also available with 12-inch treads and flat shoes for city work. You also have a choice of 60 h.p. gas or diesel engine. Better look into this 150 Trenchliner today. See your Parsons distributor — or write for 150 bulletin.

mail to: PARSONS CO., Newton, Iowa for literature on wheel-type Trenchliners: ☐ 150 ☐ 213

NAME_____ TITLE_____

COMPANY_____ DIV _____

STREET_____

CITY_____ STATE_____

Also interested in: ☐ ladder-type Trenchliners . . . ☐ rubber-tired Trenchmobile®

P554 G

PARSONS TRENCHLINERS®

(Koehring Subsidiary)

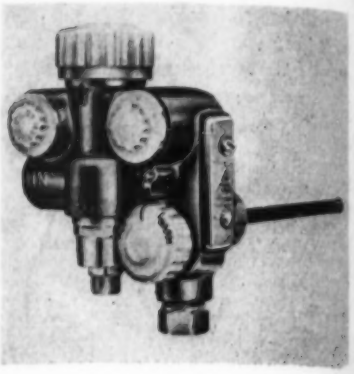
new products • *Cont'd.*

ing capacities from two to three tons.

Winter heating and summer cooling in connection with forced convectors and baseboard systems for homes and small commercial establishments are provided. An important feature is the arrangement of the water chiller in the bottom cabinet of the unit, permitting removal for servicing without disturbing the heating unit.

Hydrotherm Inc.

■



6 Snap-Action Thermostat

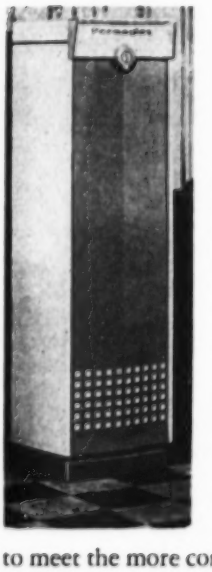
American Control Corp. is producing a new snap-action thermostat for gas storage water heaters. Known as the Ultra-Magic Model AC-100, the new thermostat has a thermo-magnetic gas flow valve, simple valve-action pilot lighting, snap-action high valve lift, and fingertip dial temperature indicator.

The Ultra-Magic is adaptable to either exposed or concealed water heater construction.

American Control Corp.

■

7 Water Heater



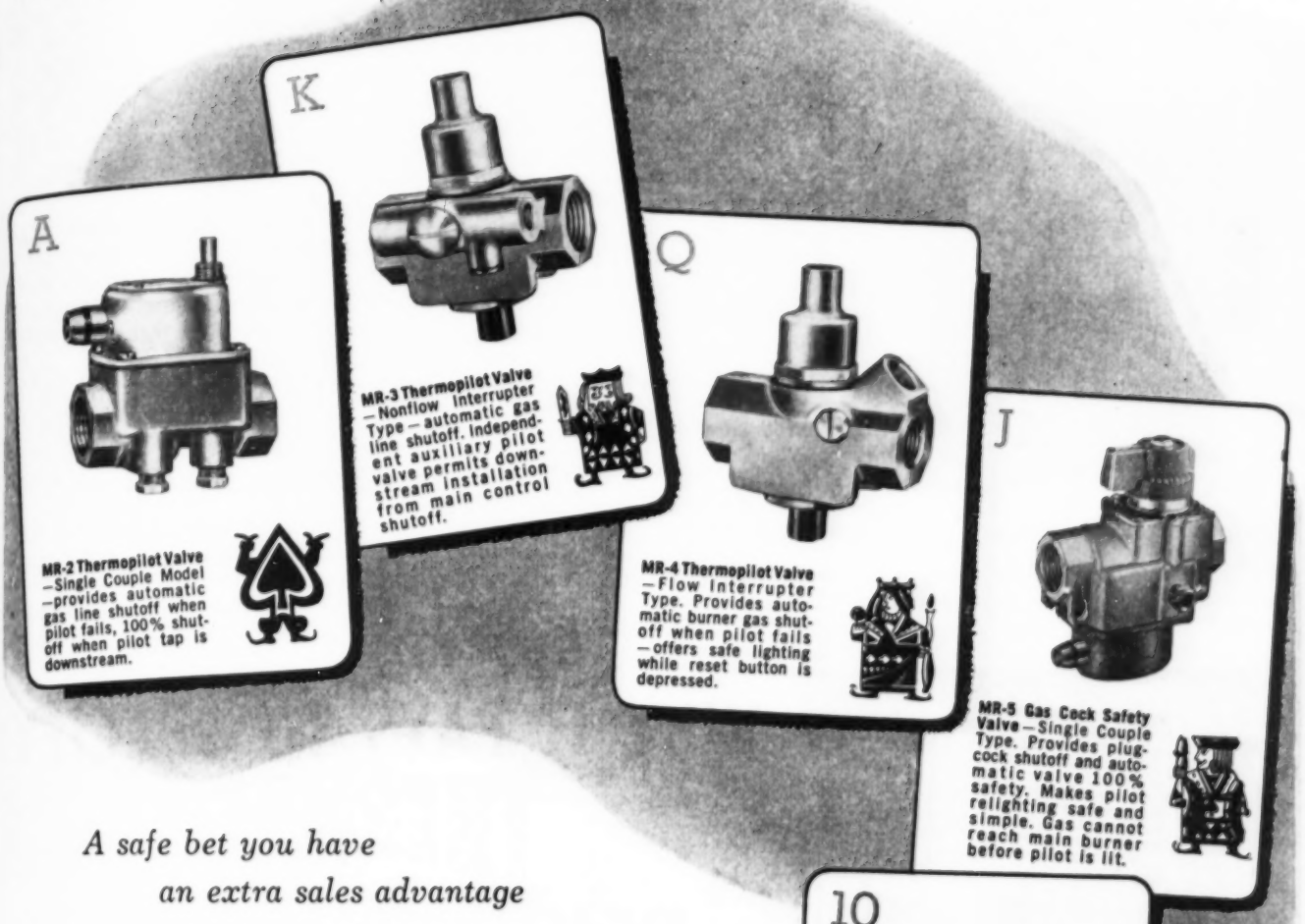
Non-cylindrical shape, eye-level temperature control knob, and the use of color are the three outstanding features of A. O. Smith's 1955 deluxe gas water heaters.

Although it still houses a round inner tank, the exterior of the Permaglas deluxe has been given a new square look with a flat front, and sides that taper slightly outward to meet the more conventionally curved posterior.

Aqua, copper, and white are used on

a SAFE BET

on any gas appliance


A
MR-2 Thermopilot Valve —Single Couple Model —provides automatic gas line shutoff when pilot fails, 100% shut-off when pilot tap is downstream.
K
MR-3 Thermopilot Valve —Nonflow Interrupter Type—automatic gas line shutoff. Independent auxiliary pilot valve permits downstream installation from main control shutoff.
Q
MR-4 Thermopilot Valve —Flow Interrupter Type. Provides automatic burner gas shut-off when pilot fails —offers safe lighting while reset button is depressed.
J
MR-5 Gas Cock Safety Valve—Single Couple Type. Provides plug-cock shutoff and automatic valve 100% safety. Makes pilot relighting safe and simple. Gas cannot reach main burner before pilot is lit.
10
MR-8 Thermopilot Valve —Single Thermocouple Model. Provides line shutoff and 100% safety. 3 stage reset knob (On, Off, Light Pilot) shows valve position at a glance.

A safe bet you have an extra sales advantage

Some people buy for economy. Some want the best at any price. But *safety* rings the bell with everyone!

That means, on any gas appliance, an automatic safety valve is one of your *better* sales features. And when it is General Controls (operating on the proved thermocouple principle)—it's the *best!* Point to the famous General Controls red shield and tell your prospect it is his best assurance of dependable performance—a safe bet for lasting *safety!*

MR

Safety Shut-off

1955 SILVER JUBILEE YEAR 25 YEARS

GENERAL CONTROLS

PLANTS: GLENDALE, CAL. • BURBANK, CAL.• SKOKIE, ILL. • 38 BRANCH OFFICES SERVING THE NATION

America's Finest Automatic Controls

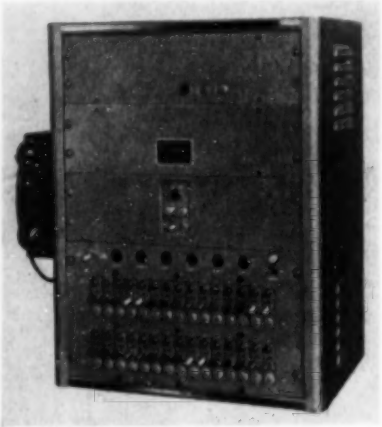
MANUFACTURERS OF AUTOMATIC CONTROLS FOR THE HOME, INDUSTRY, AND THE MILITARY

the heaters. The front panel is aqua; the cowled design of the top front is finished in copper tone.

The "Eye-Hi" temperature control provides finger-tip control for three general positions indicating warm, normal, and hot.

A. O. Smith Corp.

■



8 Digital Control System

Designed for both remote measurement and for such control functions as remote shaft positioning, on-off switching, and proportional control, Bendix Aviation Corp.'s new digital supervisory control system may be used in conjunction with an electrical transmission medium.

The Bendix-Pacific Electro-Span remote tank gauging system provides remote electrical measurement of liquid level. The system allows selection of a given tank, tank self-identification, and the transmission of level information in ⅛-in. to 60-ft increments. The information, coded in digital form, is transmitted on a two-wire telegraph circuit from the remote tank location to the central control station via the remote tank selector.

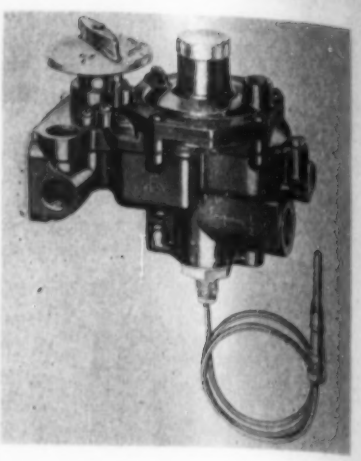
Electro-Span tone signal control is applicable for remote operation of unattended pipeline pumping stations and similar installations.

Pacfic Div., Bendix Aviation Corp.

■

9 Gas Control

A-P Controls Corp.'s new Model 55 Gasapack control actually comprises five controls—a built-in pressure regulator for city gas, a large pilot filter, a 100% automatic pilot, and main and pilot shutoffs.



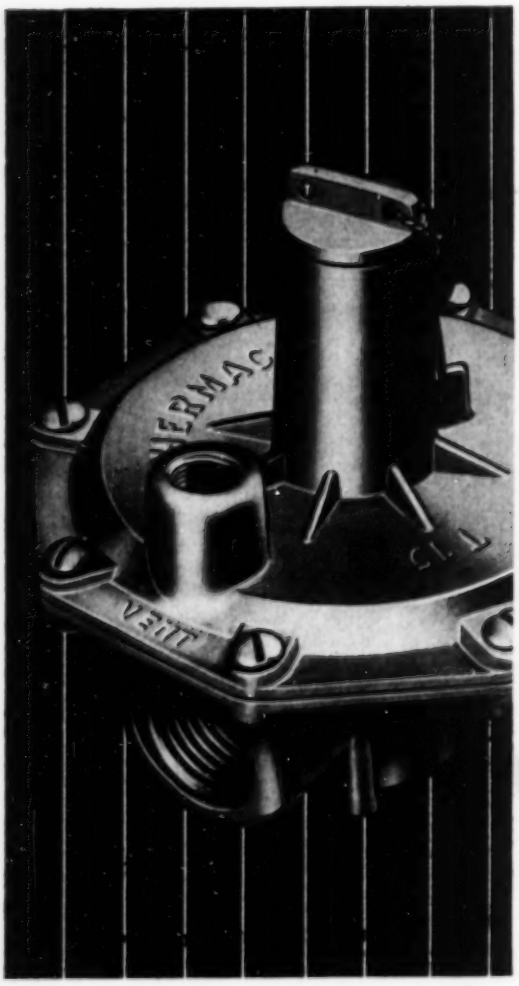
Three new automatic accessories give the Model 55 flexibility and make selection simple. They include the 55 MTS modulating snap thermostat, the 55MT modulating thermostat and the 55ET electricthermostat.

A-P Controls Corp.

■

10 Plastic Pipe Reel

Triangle Conduit & Cable Co. is now coiling its flexible plastic pipe on a disposable reel-package combination. Among advantages claimed by the



WHY IT PAYS TO SPECIFY THERMAC

GAS APPLIANCE REGULATORS

SMALL SIZE — LARGER CAPACITY is the chief reason for the unprecedented demand for Thermac pressure regulators.

EASY TO SERVICE. Few rugged parts easily accessible without removing regulator from line.

DEPENDABLE, CONSISTENT PERFORMANCE. Constant pressure regulation eliminates pilot light failures due to fluctuating pressures and assures proper operation of automatic controls.

NATIONALLY ACCEPTED by all utility companies for servicing. Standard equipment with many leading gas appliance manufacturers.

$$$ **LOW COST.** High production methods represent a saving of great importance to the appliance builder and user.

THERMAC HM COMPANY

800 EAST 108TH ST LOS ANGELES 59, CALIFORNIA

THERMAC GAS SHUT-OFF VALVE—Aluminum Alloy

This high capacity, low restriction manual main gas shut-off valve, when used with Thermac regulators, provides an unusually low cost assembly.

sell the name your customers want

. . . the name on over 5 million units now in use.
. . . for 46 years *the* name in automatic home comfort.
It's BRYANT, of course . . . the line that sells and stays sold!

be "Mr. B"

(AUTHORIZED BRYANT HOME COMFORT DEALER)

Only "Mr. B"—the Bryant Home Comfort Dealer—has *all 8* of these selling assets to build his business BIG:

1. A name customers know and want
2. The most complete line of automatic heating, air conditioning, water heating
3. Quality equipment for every market
4. Exceptional distributor service
5. Professional sales training
6. Personalized selling tools for you
7. National advertising featuring you
8. Co-op "Mr. B" ads for local papers

For bigger profits now, for a secure and prosperous future—see your Bryant Distributor. Ask him about Bryant's big "Mr. B" action program, and how it can make sales and money for you!

bryant®

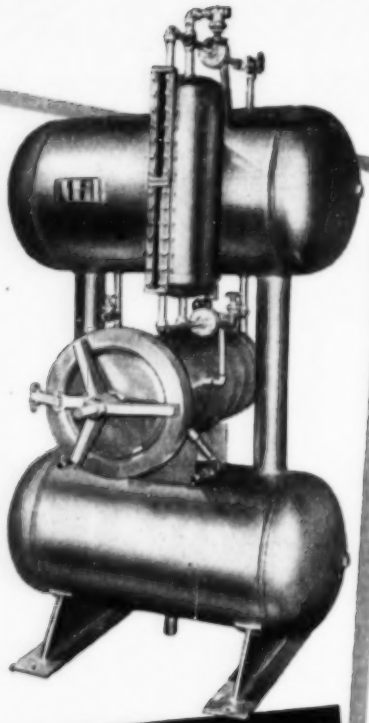
AUTOMATIC HEATING
AIR CONDITIONING
WATER HEATING

PEERLESS

Type "MP"

ODORIZER UNIT with SILLERS FLEX RING CLOSURE

The Peerless Type "MP" Odorization Unit has been designed to provide a complete odorization setup which is easily installed. This odorizer utilizes the Patented Peerless principle of liquid odorant injection.



LOOK AT THESE ADVANTAGES . . .

- Accurate proportioning of odorant into line.
- Safety tank built in. Cannot flood.
- Leakage is eliminated since all welded piping and packless valves are used.
- It occupies a minimum of space. Only one foundation needed.
- A minimum of piping is required for installation.
- Installation time is reduced.
- Maintaining odorizer is quite simple. Odorizer mechanism easily accessible.
- Positive seal of odorizer housing with Sillers Flex Ring Closure.

Write for Bulletin 904 & 905

Peerless Type "MP" Odorizers have many more outstanding advantages, all engineered to give you the most accurate odorizer available.

PEERLESS MFG. CO.

PEERLESS MANUFACTURING CO.

P O BOX 13165 ★ DALLAS 20, TEXAS ★ Dixon 8431

REPRESENTATIVES IN ALL PRINCIPAL CITIES

Meet the latest expandable type of curb meter box, the Forni type P. A.

• *Write For Details and Samples*

GEORGE P. FORNI CO.

1379 62nd St., Emeryville, Calif. • OL. 2-7410

Also Manufactured Pre-Cast Regulator Pits and Sidewalk and Traffic Type Valve Boxes

Some of Its Outstanding Features:

1. Simplicity in design—three different pieces make any size unit.
2. Strong, rigid, construction—all pieces completey reinforced.
3. Tripping hazard eliminated because of recessed cover—box can be leveled to sidewalk grade without cover in place.
4. Meter sets kept cleaner—concrete bottom cast as an integral part of box sides.
5. Ample room in box to service meters or exchange for larger size meter.

new products • *Cont'd.*

manufacturer for the package are that longer lengths help to eliminate "tag-end" short pieces; the pipe can be pulled off the reel easily and quickly; the reels are designed to stack compactly, saving warehouse space and protecting the pipe from dirt and sunlight during storage; and the packages protect the pipe from mechanical damage during shipment.

Triangle Conduit & Cable Co.

■

GAS trade literature

11 Neoprene Pamphlet

"Neoprene Notebook," published by E. I. DuPont de Nemours, presents facts about neoprene of interest to engineers. This issue (No. 62) presents information on such subjects as the thermal properties of rubber, neoprene hoses, balls, coatings, and seals.

E. I. DuPont de Nemours & Co.

■

12 Tape-Use Manual

Polyken Products has issued a new revised tape-use manual, representing a fundamental, basic sourcebook for current industrial tape usage. The manual classifies applications of tape, shows the Polyken tape best suited to each application. Another section is devoted to the basic industrial uses for tape.

Polyken Products

■

13 Plastic Pipe Catalog

How to use and specify rigid plastic pipe and fittings is the subject of a new 12-page catalog published by Alpha Plastics. Created to enable engineers to learn the modern uses for plastic pipe, the catalog provides reference facts on Alpha's normal and high impact unplasticized polyvinyl chloride pipe and fittings. Also featured is a corrosion chart classifying more than 275 corrosives.

Alpha Plastics Inc.

■

14 Refractories Booklet

Carborundum Co. has issued a 24-page booklet that presents the latest physical and chemical properties on super refractories. The data are assembled in easy-to-find style and are augmented by lists of applications together with pertinent charts and tables.

Carborundum Co.

GAS news

Big construction plans announced for 1955

Among major expansion and construction programs scheduled for 1955 are those of Lone Star Gas Co., Dallas, $11,669,100; Seattle Gas Co., $1.2 million; Northern Illinois Gas Co., $16 million. Western Pennsylvania gas companies will spend $39,504,750 this year for improvement and expansion of gas service in that area.

Lone Star expects to add 35,000 customers in 1955 and estimates that by 1960 it will serve a total of 1 million customers. The breakdown of its $11,669,100 budget for 1955 is as follows: transmission, $5,682,700, for gathering and transmission facilities, city gate stations and tap lines, dehydration plants, new and enlarged gasoline and compressor facilities, strengthening of underground storage facilities; Dallas division of distribution, with $3,562,200, will build 125 miles of distribution mains in addition to miscellaneous activities; Fort Worth, with $2,996,400, will build 80 miles of feeder line and distribution main extensions, plus service lines, new meters, regulators, etc.; Lone Star Producing Co., with $6,118,200, will drill 63 wells in Texas, Oklahoma, and New Mexico.

Seattle Gas Co. will spend $1.2 million for its system expansion program, plans 12- and 16-in. gas mains through the city's industrial area. From this system new gas mains will be laid to service west and south Seattle residential areas. The company will also build transmission mains from its city gate stations.

The Pennsylvania Natural Gas Men's Association reports the following breakdown of $39,504,750 to be spent in western Pennsylvania: $7,202,100 for transmission; $7,785,000 for storage; $9,056,500 for exploration and production; $12,699,500 for enlargements and additions to utility distribution systems; $2,761,650 for miscellaneous.

Northern Illinois Gas Co. has budgeted $60 million for construction during the next four years, with $16 ear-

→ A Completely NEW LINE of Service Bodies with

25 FEATURES

that give a new meaning to "UTILITY"

Model 900 D with upper structure

Model 1050 D

1. Models to fit 40 different Chevrolet, Ford, International, GMC, Dodge and Studebaker chassis . . . single or dual wheel.
2. For ½ - ¾ - 1 - and 1½-ton trucks.
3. 18 different compartment arrangements.
4. Exclusive 4-point coil spring body mounting.
5. Complete line of Service Accessories.
6. Bonderized, all-steel welded construction.
7. Double lap-type joints.
8. Extra-wide doors for easy access.
9. Larger, greater capacity compartments.
10. Embossed door panels for rigidity and appearance.
11. Fully recessed door handles.
12. All doors keyed alike.
13. Tumbler-type locks at no extra cost.
14. Full bolt-action locking bar.
15. Weatherproof compartments . . . lap-seal and gutter drain on all doors.
16. Raised bottoms of all vertical compartments provide extra protection for tools and supplies.
17. Heavy-duty reinforced 16-gage bulkheads.
18. Outside compartment headers 14-gage steel.
19. 4-way, 12-gage, safety tread non-skid floor.
20. From 25 to 35 sq. feet of floor loading area.
21. Through wheel housings for universal dual wheel application.
22. Reinforced tailgate.
23. Extra strength, bridge-type construction with interlocking lateral and longitudinal reinforcements.
24. Side boxes supported by one-piece cross members, reinforced at mounting holes.
25. Beaded fender panels hinged for easy access to wheels and spring shackles.

For Better Service and Greater Utility . . . Specify

Morrison service bodies

→ WRITE FOR DETAILS:

Morrison Service Body Division
MORRISON STEEL PRODUCTS, INC.
696 Amherst Street Buffalo 7, New York

• Also manufacturers of MOR-SUN Furnaces and ROLY-DOOR Steel Garage Doors

marked for this years construction, which will be mainly for extensions to serve new customers and for expansion of existing facilities to meet residential space heating load demands.

Production to be doubled at Grayson's new plant

Robertshaw-Fulton Controls Co. will be able to double its production of thermostatic controls and ignition devices for gas heating appliances at its new Grayson Controls division plant in Long Beach, Calif.

Modern glass-and-stone entrance to new $3 million Grayson Controls plant, which will produce automatic control devices for home appliances and industry.

The $3-million plant, formally opened Feb. 2, has 237,000 sq ft of floor space, almost twice that at the division's former location in Lynwood, Calif. John A. Robertshaw, president said the new plant will permit greatly increased production almost immediately. The division's product line will be expanded as well.

Opening of the plant completes another major link in Robertshaw's current national expansion program. The company has added new facilities at Irwin and Indiana, Pa.; Anaheim, Calif.; and Toronto, Canada, during the past year, and presently has a $2 million plant under construction at Milford, Conn. for the Bridgeport Thermostat division.

The Grayson division has approximately 950 employees and an annual payroll of more than $4.5 million. In coming months, the division plans to add an additional 900 employees.

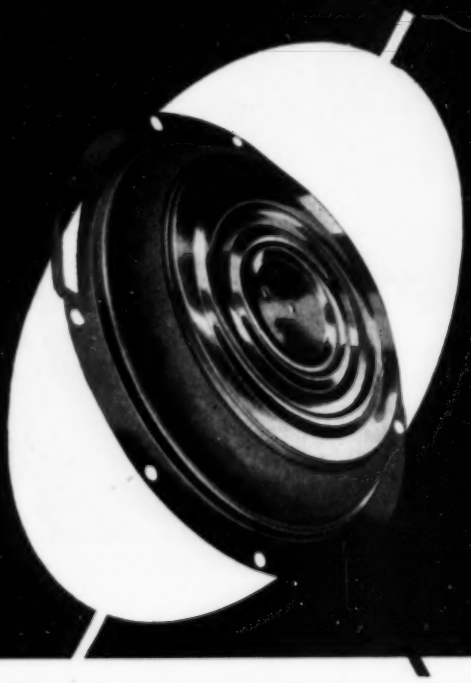
Bureau of Reclamation tests protective coatings

The Bureau of Reclamation of the Department of the Interior employs a screening test to weed out less effective coatings and to select for its use the best protective coatings available for a particular environment.

In endeavoring to keep abreast of new developments in the protective coating field, the bureau uses laboratory soil-stress tests to evaluate the resistance of protective coatings to the tearing action resulting from expansion and contraction of clay soils.

Briefly, this test consists of covering the variously coated 3-in. pipe sections with a clay slurry, then thoroughly drying the clay over a two-week period with the use of infrared lamps. Up to

BETTER
BEST



When it comes to the diaphragm data in your meter service records, you'll see better over-all accuracy and longer service life with Lancaster Groove Type Metal Rim Diaphragms in your meters.

From the groove type design which assures equal leather at both "in" and "out" stroke extremes . . . to the fine specially processed leather itself, Lancaster has the edge in practical engineering, quality materials and precision workmanship.

Send for a sample and see for yourself

METER PARTS CO.

THE NEW '55
DETROIT JEWEL
GAS RANGE LINE
Invites Comparison

THE ONE GAS RANGE WITH ALL THE FEATURES VOTED *"Most Wanted"* BY TODAY'S WOMEN!

Model illustrated is #552-3

FEATURING

- Handee-Hi Broiler
- Exclusive Signa-Dials
- Handy Top-Center Griddle with a Glass Oven Door
- Automatic Clock Controlled Oven
- Extra-large Chrome Oven
- Exclusive Top-Vue Oven Window
- And Many More Sales-Closing Features

COMPLETE LINE

- ★ Big 39″ Range Series
- ★ Budget Priced 36″ Range Series
- ★ Popular 31″ Ranges
- ★ Space-Saver Compact Models
- ★ Built-In Model Dual-Action Incinerator

Over the past 90 years, the Detroit-Michigan Stove Co., has been a major factor in the tremendous growth and development of the gas industry. Sale of its products automatically reflects in gas sales because a D-M-S sale is a gas sale. With D-M-S expanding its great range line and services, gas, too, will grow accordingly. Most certainly, gas, the ideal fuel, is at its best with Detroit-Michigan Stove Co. products.

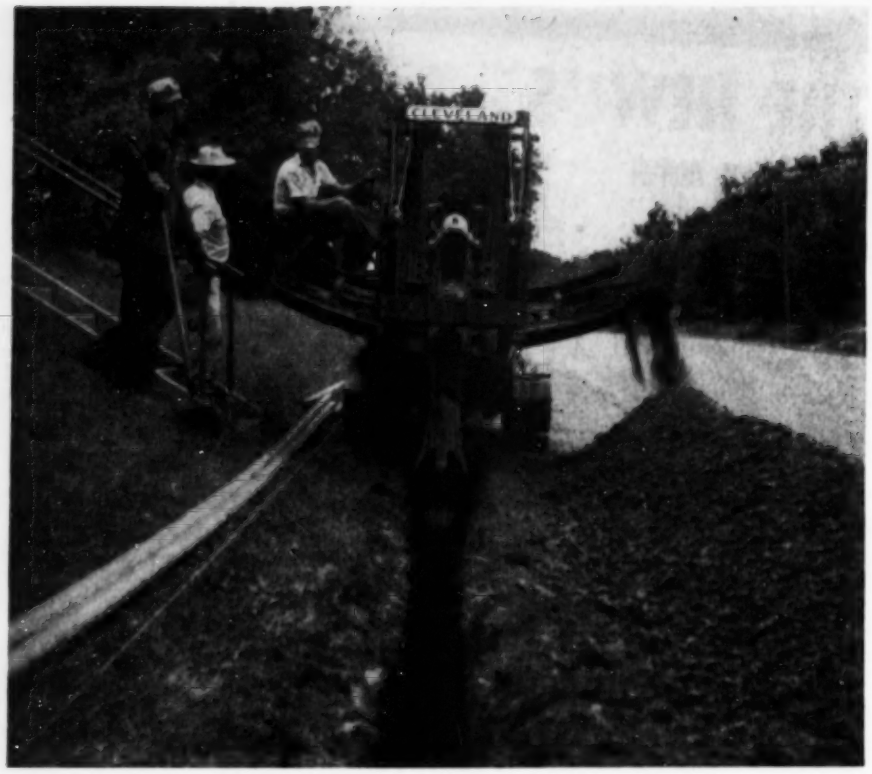
FINE RANGES SINCE 1864

DETROIT JEWEL

Products of the Detroit-Michigan Stove Co.
Detroit 31, Michigan

Makers of the
Famous Detroit Jewel Incinerator

DM PRODUCTS



Repair cost = $\frac{1}{50}$ ¢ per foot on 120,000 feet of extension work

CENTRAL ELECTRIC & GAS CO., Lincoln, Neb. with their Cleveland "Baby Digger" consistently dig an average of about 200 feet of trench per hour . . . a good production average on gas extension projects where numerous line obstacles are encountered both above and below ground.

Their Cleveland, shown above working easily along the edge of a lawn, recently completed more than 600 hours of trench digging—about a half year's work on use of this kind—with no need of repairs or parts replacement due to wear, or maintenance of any kind except normal lubrication and fueling. (One shaft was broken by improper sprocket installation during the regular operator's vacation, at a cost of $28.)

Performance like this—plus compactness and maneuverability, big capacity, and dependability in turning out high daily footage regardless of soil and weather conditions—goes a long way toward explaining why Cleveland "Baby Diggers" have been the gas industry's choice in trenchers for well over 30 years.

Fast moving, too! . . . Cleveland "Baby Diggers" hustle safely from job to job . . . at legal speed limits . . . because they are so easily portable on fast loading Cleveland trailers.

Write for Full Line CLEVELAND *Bulletin or see your Local Distributor*

THE CLEVELAND TRENCHER COMPANY • 20100 St. Clair Ave., Cleveland 17, Ohio

CLEVELAND

25 cycles are used to evaluate comparative performance. The same coatings are subjected to a deformation test to determine their resistance to puncture by backfill materials.

At present, the test results have shown the need of a felt wrap when coal-tar and asphalts are used; and under severe conditions a glass mat reinforcement should be used in conjunction with the wrap. The felt wrap, to perform satisfactorily, must be well bonded to the coating material with a continual bear at the felt overlaps. However, if severe soil conditions exist it appears that a single glass reinforcement would not provide sufficient protection, and that perhaps two separate layers of the glass mat reinforcement would be required. The good performance of a double wrap of a glass-reinforced coal-tar enamel tape supports this conclusion, according to Paul W. Lewis, engineer in the paint laboratory of the bureau in Denver.

Microcrystalline wax and gilsonite, both with a microcrystalline wax wrapper, and vinyl and polyethylene tapes all have performed well in the laboratory soil test and would be expected to perform well in service except possibly for the most severe soil conditions. A reinforced cement mortar coating developed a few hairline cracks early in the test, but since has remained virtually unaffected, and from the standpoint of resistance to soil stress, is a superior coating material.

Walworth to market plastic valves, fittings

Walworth Company this year will sell a line of plastic valves and fittings under the Walworth name and trademark through the company's existing sales channels.

The plastic products will be manufactured to Walworth specifications by General American Transportation Co. of Chicago. This exclusive arrangement with GATC will provide Walworth with plastic products by June 1955 at relatively low capital investment.

Lloyd Logsdon honored on retirement from Mueller

Approximately 450 persons from seven states and the Hawaiian Islands attended a reception and dinner Feb. 5, at the Ambassador hotel in Los Angeles honoring Lloyd Logsdon, retiring vice president and general manager of the Mueller Co.'s West coast sales and plant operations in Los Angeles.

At the party honoring Mr. Logsdon were (from left): Mr. Hipsher, Mr. Logsdon, Mr. Morris, and Thomas F. Leary, who hired Logsdon 35 years ago.

Attending from the firm's headquarters in Decatur, Ill., were William H. Hipsher, executive vice president; Robert H. Morris, vice president and general sales manager. Mrs. Robert Mueller of Decatur and Mrs. William E. Mueller of San Mateo, California, also were present.

Mr. Logsdon's retirement Jan. 1 ended 35 years service with Mueller Co. He began as a salesman in 1919, later became sales manager and finally was elected vice president and general manager of the company's West Coast operations.

Sales record seen in '55 by gas appliance men

Gains ranging from 2.6% to 8% in its principal manufacturing categories have been forecast for 1955 for the gas appliance industry. The survey, conducted by GAMA, indicated that the industry may top its previous record year, 1950.

Optimism pervades the entire industry, highlighted by a particularly bullish outlook on the part of manufacturers of gas furnaces, which set an all-time record by shipping 670,000 units in 1954.

Edward R. Martin, GAMA director of marketing and statistics, reports that manufacturers of gas ranges, automatic gas water heaters, boilers, conversion burners, clothes dryer, and incinerators also anticipate sales increases.

Only one gas furnace manufacturer out of 48 who participated in the survery expects his sales curve to dip in '55, while 40 of them expect their business to increase. While the concensus for the entire industry points to an increase of only 8%, attainment of all the individual company expectations could produce an increase of more than 27%. "That is what happened in 1954," according to Mr. Martin.

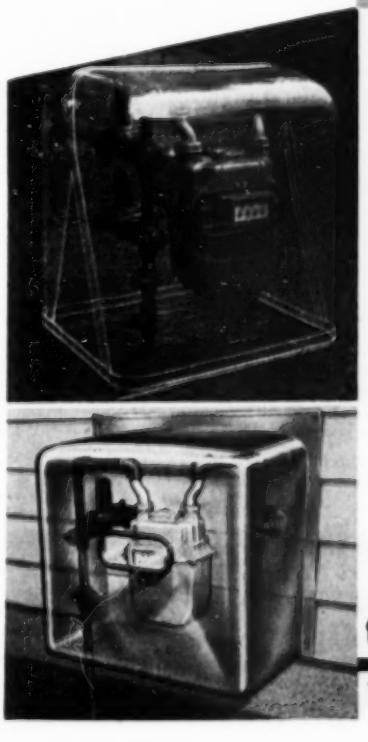
He reported a similar situation among gas boiler manufacturers. Eighteen of 24 participants anticipate higher sales, while only one expects a decrease. With each company performing up to expectations, sales could show an increase of 14%. Gas conversion burner sales may rise as much as 20%, if 25 of 38 reporting companies attain the increases they expect.

Sales of automatic gas water heaters,

Yard model (right) sits directly on ground, with no rot or corrosion danger. Can be fastened to stakes. Wall model (above) has slots in flange, slips over screws.

Meter Dome

solves housing problems, cuts reading costs



Meter readers can make up to twice as many calls per day when sets are outside, and protected by a genuine one-piece Fiberglas Meter Dome. Emergency shut-offs are quicker, servicing is easier, annual painting is unnecessary, and installations are more economical.

Get the complete story today on money-saving plastic Meter Dome. It's your best buy in the meter cover field.

Transparent models (left) show roominess of Meter Domes. Either one easily holds any size domestic meter, meter bar and regulator.

the Buckeye Supply Co.

18 HARRISON AVE. • ZANESVILLE, OHIO

which established an all-time peak of 2,364,500 units in 1950, may reach a new high this year. While only 19 of 33 reporting companies expect the industry as a whole to register an increase, 28 of them expect their own company sales to go up.

Manufacturers of domestic ranges are confident that the downward trend, which set in after their peak in 1950, has been arrested and that 1955 will produce a sales increase.

There's good reason for manufacture optimism, Mr. Martin said, in the fact that the gas industry will spend $1.1 billion on utility company and pipeline construction during the coming year, bringing gas to new communities and increasing the supply to communities where demand has exceeded the available gas.

Another favorable factor is the probability of an all-time high in new housing starts, particularly in single family dwellings, where gas is the predominant fuel for comfort heating, cooking and water heating. Liberal financing terms under the Housing Act of 1954 will facilitate purchases of homes equipped with all gas appliances.

"I got the idea from Standard Magnesium's VIBRA-PAK Anodes . . ."

We're not so sure it's cricket to carry your own sod on the golf course. But there ARE times when carrying your own soil can mean quite a saving in time, trouble and expense. That's why every VIBRA-PAK Anode is delivered to you already compacted and centered in backfill, ready to drop in the hole. You get BETTER positioning . . . EASIER installation . . . FASTER installation, every time.

There are several other good reasons for specifying Standard Magnesium VIBRA-PAK Anodes, too. The patented spiral core, for example . . . which really stays put; won't separate from the anode. And, of course, the best reason of all; the magnesium in each VIBRA-PAK Anode is spectrographically analyzed to assure you of *greater purity* . . . more current per pound.

Next time the job calls for dependable Magnesium Anodes to aid in controlling corrosion, specify VIBRA-PAK . . . the "pre-packaged" Anode that carries *it's own backfill.*

Standard Magnesium Corporation
TULSA, OKLAHOMA

Pioneers of: SPECTROGRAPHICALLY ANALYZED ANODES AND CYLINDRICAL ANODES

A continuing increase in the use of LPG, utility company expectations of 1.2 million new house heating customers annually for the next three years, and intensified sales promotion, advertising and merchandising by all segments of the industry were also cited as factors that would help manufacturers attain anticipated sales increases.

New meter record set by SoCounties in 1954

A new record for number of meters added in one year in its system was set in 1954 by Southern Counties Gas Co., Los Angeles.

By adding 39,097 new meters in its eight operating divisions during the year, the utility topped the prior high mark of 35,471 new meters of 1953 and brought to 497,783 the total number of meters it serves. Company-wide percentage of meters added during the year was 8.52 over the 458,686 meters the company served as of Dec. 31, 1953.

Since number of meters reflects general development of an area, fastest growing territories served by the company are Orange county and the Pomona area.

SoCounties says it expects to add 53,000 new meters throughout its system in 1955.

Huge heating equipment future seen for 1955-59

More than 3¼ million units of gas heating equipment can be sold during 1955 if the gas industry exerts maximum promotional effort and product design improvement. For the period 1955-1959, the potential aggregates 20.6 million units, according to a study made by the AGA. These potentials compare with actual sales of 2.9 million in 1953 and 2.7 million units in 1954. For the five years ending with 1954, total actual units sales were 15.1 million.

If the industry maintains the present pace in promotional activity and product improvement on heating equipment, sales during 1955 will aggregate 2.8 million units and a total of 14.4 million during the five year period. All potentials are based on a continuation of 1954 levels of disposable incomes. In computing potentials, consideration was given to limitations on the connection of new heating customers still existing in some areas.

Potential sales of central heating units during 1955 aggregate 960,000. If no improvements in promotional effort and product design are effective during the year sales will total 880,000. During the five years 1955-1959 total potential sales of central heating equipment will equal 4.75 million units. It is estimated that sales will aggregate

4.13 million if promotional effort and product development remain at current levels.

The potentials for central heating equipment represent only a modest increase from sales at current levels because the market for gas central heating equipment as a replacement for competitive fuels is constantly diminishing. This replacement market, which represents about one-third of the total central heating market, has become more saturated and fewer eligible homes remain. Many of the eligible homes still remaining are concentrated in areas remote from gas fields where the fuel price pattern is less advantageous to gas.

It is probable that new housing will exceed an annual average of one million units for the remainder of this decade, then will increase to reach 1½ million units per year in the middle of the next decade. In addition, a substantial market exists for replacement of gas conversion burners installed in early post-war years in older heating equipment and boilers which will soon require replacement.

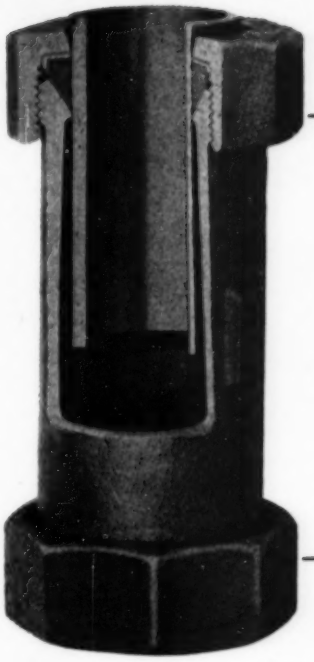
Potential sales of floor and wall furnaces during 1955 are 575,000 units, and for the five-year period ending in 1959 they aggregate 3.15 million units. With sales and developments efforts continuing at present levels, the anticipated sales during 1955 will total 475,- units and will be 2.53 million units for the five years. The new housing market continues to represent the greatest potential for such equipment because of the relative recency of acceptance of floor and wall gas heating units.

Gas space heaters have a potential sales volume of 1.7 million during 1955 and 12.7 million during the five-year period commencing with that year, with a maximum promotion and development program. At current levels of such efforts sales in the forthcoming year will be 1.45 million and during the five-year period will total 7.7 million units. The present low replacement rate can be accelerated by better design and promotion effort and if more emphasis is placed upon the need for venting.

Rhode Island's rates to be investigated

Claiming that Rhode Island has the highest rate bracket in the nation, Sen. Ralph T. Lewis has proposed an investigation of the state's public utility rates.

The resolution, sent to the finance committee, would form a three-member committee—made up of an engineer versed in utility operations and appointed by the governor, an accountant appointed by the house speaker,



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So close are "Normac" rubbers confined at the gasket tip that possibility of flow is reduced almost to "nil." These couplings, sleeves and fittings . . . approved by gas utility men across the country for their time-saving features, ease of handling and dependable service . . . are available in a complete range of sizes. Made from air furnace malleable iron they provide greater wall thickness than pipe on which used.

NORMAC COUPLINGS are made with 5" centers in all sizes. NORMAC SLEEVES are identical in design except that they are made with 10" centers. Nuts and gaskets are interchangeable.

Compression-End Service "Tee"—First fitting of this type ever produced with full coupling depth and special threads on male end to prevent dropping into old hand taps when used to replace standard threaded fittings.

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Normac Brass Fittings Developed in 1939 for Use with Copper Tubing—Our complete line of brass fittings can be used either on new installations or where copper is run through old steel pipe in large or small openings. The center to end dimensions of NORMAC TEES correspond with old malleable iron fittings. This feature is extremely important in the use of these fittings in one foot openings where the tubing must line up with the steel which has been removed.

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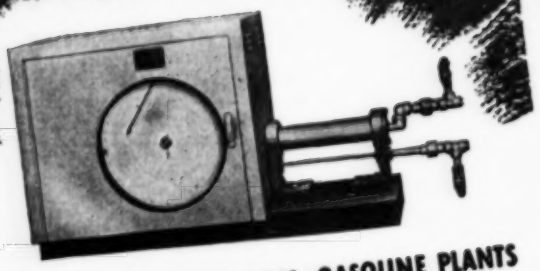

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General Controls expanding Glendale, Calif. facilities

Current expansion projects at General Controls Co., Glendale, Calif., will result in the expanison of both the engineering and administrative facilities.

A 15,000-sq ft two-story addition will adjoin the present engineering area. It will be used for both tooling and engineering, particularly in the research and development phases.A second story is being added to the main administrative building, increasing the office area by one third. This expansion will provide facilities for new methods of market analysis and electrodata automatic business machines.

J. M. Kobabe

R. W. Pixler

Mettler merges with Eclipse Fuel Engineering

Mettler Co., Inc., Los Angeles, has been merged with Eclipse Fuel Engineering Co., Rockford, Ill. Mettler will continue to operate as the Mettler Co. Inc., division of Eclipse. All manufacturing and sales will be handled in the West coast offices and plants.

R. W. Pixler, former manager of combination gas-oil burner sales of Eclipse, has been appointed vice president and general manager of the new division. James M. Kobabe, president of Mettler, will continue to be associated with the company in a consulting capacity.

Continued expansion is expected, with the company contemplating the introduction of a new dual-fuel burner in the near future.

Eight-million dollar loss reported by Servel

Cutbacks in defense production and depressed markets for civilian products resulted in a net loss of $8,157,766 for

Servel Inc. during the fiscal year ended Oct. 31, 1954, according to the company's annual report to stockholders. The 1954 loss compared with a net loss for the previous fiscal year of $1,983,511, after a tax recovery of $1,029,400.

Net sales in 1954 totaled $87,817,080, as compared with all-time high net sales of $147,586,716 in 1953.

Defense product sales declined from $89,357,487 in 1953 to $44,472,231 in 1954, and civilian product sales declined from $58,229,229 in 1953 to $43,344,849 in 1954.

Twenty-fifth year being marked by General Controls

As one of the exhibitors at the January Home Builders Show in Chicago and at the Heating & Ventilating Exposition in Philadelphia, General Controls Co., Glendale, Calif., began its celebration in 1955 of the company's 25 years as a manufacturer of automatic controls for home, industry, and military use.

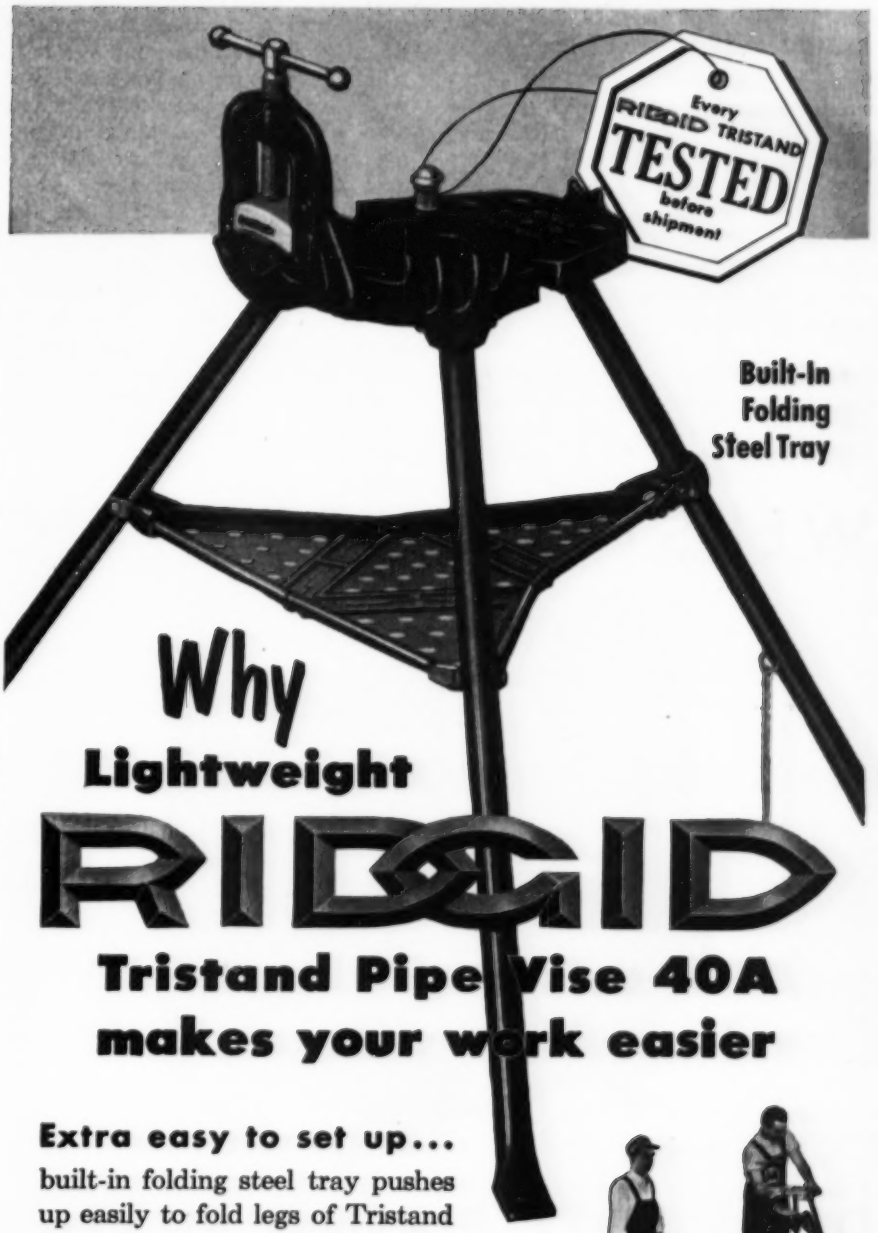
The company was organized in 1930 in Oakland, Calif., when William W. and Charles Ray borrowed $10,000 from their father and opened a factory in a small attic. Today, with headquarters in Glendale, the company has manufacturing plants in Glendale, Skokie, Ill., and Burbank, Calif. Employees now number more than 1700 throughout the country and General Controls has 38 branch offices as well as a wholly owned subsidiary in Toronto, Canada.

GAS news notes

Zenith Plastics Co., Gardena, Calif, has announced the appointment of the Sprague Meter Co., Bridgeport, Conn., as exclusive distributor of Zenaloy plastic gas meter covers. Sprague will offer designs for housing most types of meter installations.

Eleven thousand safety experts will gather in New York for five days of conferences, starting April 11, aimed at reducing this country's annual accident toll. New York's 25th annual safety convention and exposition will be held in the Hotel Statler under the sponsorship of the Greater New York Safety Council and 71 cooperating agencies.

The pipeline locator manufactured by Wilkinson Products Co., Pasadena, Calif., was used recently to locate a load of pipe that had shifted on a barge and was lost three miles off shore in the Gulf of Mexico off of Corpus Christi, Texas. Mounted on the bow of a wooden skiff, the electronic locator regis-



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built-in folding steel tray pushes up easily to fold legs of Tristand for easy carrying; tray pushes down easily to set up, holds stand solidly rigid.

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extra-strong stand and tray all one unit. Full size vise-base has 3 benders, ceiling brace screw, lots of tool slots, besides handy tool tray. Most for your money—your Supply House has them, can demonstrate and deliver fast!

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RIDGID
Work-Saver Pipe Tools

tered the presence of the pipe in several piles over a distance of 250 yards. Complete recovery was made.

Key City Gas Co., Dubuque, Iowa, has been consolidated with the gas companies in Fort Madison, Perry, and Algona as the North Central Public Service Co. of Dubuque.

Fisher Governor Co., Marshalltown, Iowa, has purchased a factory in Woodstock, Ont., Canada, and will start manufacturing diaphragm motor valves, liquid level controllers, and gas regulators there this spring. William J. Bestmann, who has been in charge of production scheduling in Marshalltown, is moving to Woodstock as general manager of the Canadian plant.

One-hundred and seven separate employee groups of the Lone Star Gas Co., Dallas, and its subsidiary, Lone Star Producing Co., have attained perfect safety records representing 19,169,199 hours of work without a lost-time accident. The records, ranging from one through 26 years as of Dec. 31, 1954, represent a cumulative total of 457 years. Last year the 107 employee units amassed 5,433,516 accident-free hours.

Minneapolis-Honeywell Regulator Co. will construct a multi-million dollar factory, engineering and office building adjacent to its present plant in Gardena, Calif., to meet mounting demand for gas appliance controls on the Pacific Coast. The new addition will more than double the current operations.

Niagara Mohawk Power Corp. has been authorized by the New York PSC to connect 14,000 additional space-heating installations throughout its service area. Ruling that the company's gas supply would be adequate to serve the additional customers, the commission also told the company it may add to the new installations the rest of unused prior allocations on a systemwide basis.

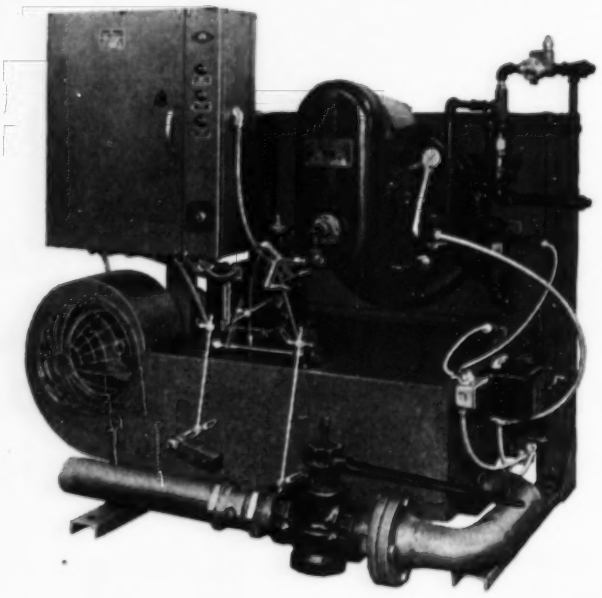
A branch sales and engineering service office has been opened in Hammond, Ind., by Minneapolis-Honeywell Regulator Co. O. V. Spousta, formerly manager of Honeywell's branch office in Louisville, Ky., will manage the new office.

The price index of natural gas common stocks reached a new two-year peak on Jan. 28, according to AGA report. The composite price of the common stocks for the companies comprising the index was 18.9% greater than on the comparable day one year prior. Dividend increases of only 7.4% on these stocks, however, resulted in yields declining from 5.07 to 4.58%, a relative decline of 9.7% over the year.

Public Service Gas & Electric Co., Newark, has asked the New Jersey PUC to approve a plan to distribute straight natural gas to consumers in outlying sections of its territory, including areas of Bergen, Morris, and Passaic counties. Public Service said the proposed change would give greater assurance of adequate and quick service to its customers in those areas and would be effected without cost to the customer and without changing the cost of gas.

The Institute of Gas Technology has announced the availability of its annual fellowships leading to the Master of Gas Technology and Doctor of Philosophy degrees, and of scholarships in the gas option in chemical or mechanical engineering. In an attempt to obtain the maximum publicity for these two features of the educational program, IGT has circulated junior colleges and the chemical, mechanical, natural gas, and petroleum engineering departments of accredited colleges in the U. S.

WEBSTER ROTONETIC*



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- Low installation costs.
- Maximum efficiencies on BOTH gas and oil.
- Minimum base height requirements.
- Utilizes all grades of fuel oil.
- Extremely low noise level.
- Approved electronic combustion safeguard system.
- Simpler changeover than ever before.
- One hundred per cent forced draft.
- Completely assembled, piped, wired and tested.

These and many other outstanding features combine to provide the same dependable high quality performance as the WEBSTER DYNETIC gas burner. Neither fuel must suffer if the WEBSTER ROTONETIC is used. With integral pumps, integral oil preheaters for heavy oils, patented oil burner "flame-shaping" vanes, and full modulating or optional high-low control, the WEBSTER ROTONETIC is designed to provide long lasting customer satisfaction the year around.

It is furnished with a precast refractory front as an integral part of the burner assembly. The installer need only finish the furnace wall on each side and above the burner.

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Division of SURFACE COMBUSTION CORPORATION, Toledo, Ohio

GAS people

Promotions

Major personnel changes to fill four new supervisory assignments have been announced by Southern California Gas Co., Los Angeles. J. N. SHRADER, former manager of customer service, is manager of division coordination; GORDON G. DYE, former northern division manager, is assistant manager of distribution; D. R. WOOD, former superintendent of automotive equipment, is supervisor of special services in central division. In addition, R. F. OBGORN is manager of customer service, L. E. GREEN is manager of the customers department, E. F. HAWKESWORTH is southwest division manager, L. E. DERRICK is northern manager, and J. S. GREEN is supervisor of the accounting staff in the controllers department.

J. N. Shrader

G. G. Dye

Southern California

Minneapolis - Honeywell Regulator Co. has made three field personnel changes in its Midwest region: ARNOLD CHALLMAN is now administrative assistant to Manager T. S. Carley in Chicago; R. C. FERGUSON will manage the Peoria branch office and P. R. SCOTT is the new manager of the Davenport office.

HUGH L. WATHEN has been elected vice president in charge of sales and public relations by the South Jersey Gas Co., Atlantic City.

J. H. LAMBDIN, former operating superintendent, has been named general superintendent of Mississippi Valley Gas Co., Jackson, Miss. He succeeds the late GLENN C. JONES.

Ebasco Services Inc., New York, has appointed A. T. LARNED as consulting civil engineer, C. C. BONIN as chief civil engineer, and A. C. CLOGHER as an associate consulting engineer.

Recent promotions and appointments at Servel Inc., Evansville, Ind., include the following: JAMES F. DONNELLY, vice president in charge of sales, is now vice president in charge of trade

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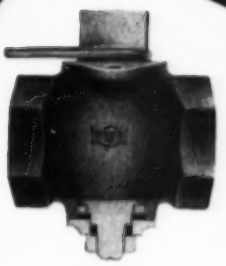

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"Key-Lok" Tamper Proof Stop Lockwing—Iron Body, Bronze Plug

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Threadless Gas Stop Iron Body, Brass Plug

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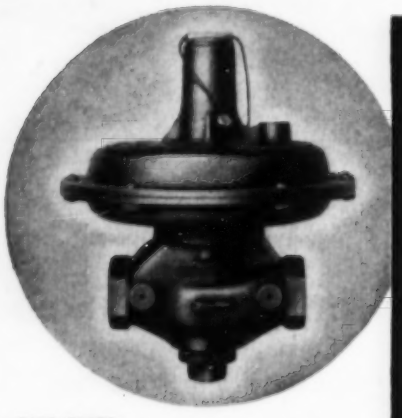

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and industry relations; JOHN H. WALL is a vice president and general manager of the self-contained home appliance division; ALLEN E. APPLE, formerly industrial relations manager, is manager of employee relations; and JACK HEWSON, formerly publicity manager, is director of public relations.

Philadelphia (Pa.) Electric Co. has announced the following appointments:: W. H. JONES, manager of purchasing and service operations; MILTON I. ALLEN, general sales manager; PHILIP M. ALDEN, sales manager, residential department, succeeding AUSTIN MONTY, who was appointed sales consultant; FRANK E. CHENEY heads a newly created department as manager of merchandise sales. Other appointments include MAXWELL COLE, assistant sales manager, industrial and retail department; FRANK C. SHERMER, manager of market studies and service division; CHARLSE C. SHOTWELL, manager, industrial engineering division; ARNOLD D. SPILLMAN, assistant manager, market studies and service division; and ALBERT G. GARRIGUES, manager, retail division.

ROY E. JONES has been elected president and a director of North Shore Gas Co., Waukegan, Ill.

DEL PENDERGRAST has become director of publicity for Northern Illinois Gas Co. He was formerly editor of the *Public Service News* and assistant to the director of publicity for Public Service Co. of Illinois.

PETER F. LEUSCH, treasurer of the East Ohio Gas Co., Cleveland, has been named a vice president in charge of financing and accounting.

A. E. HESS has been named Southwest regional manager of General Controls Co., Glendale, Calif. He will maintain his headquarters in Dallas.

FRANCIS B. FLAHIVE, vice president in charge of insurance, pensions and motor vehicle operations, has retired

A. W. Stewart
Columbia Gas

A. E. Hess
General Controls

after 28 years of service with Columbia Gas System Service Corp. ARTHUR W. STEWART has been named director of transportation, a newly created title since Mr. Flahive's retirement.

LUDLOW SHONNARD JR. and JAY DAVIS JR. have been elected directors of Southern Counties Gas Co., Los Angeles. Both are vice presidents, Shonnard in charge of the company's personnel, claims and industrial relations activities and Davis in charge of construction and distribution.

LESTER L. LUXON, technical editor of BUTANE-PROPANE *News*, companion publication of *GAS*, has been elected vice president of the unit construction division of American Liquid Gas Corp., Los Angeles.

J. L. LOGSDON, vice president and general manager of Mueller Co.'s Pacific Coast factory in Los Angeles, has retired after 35 years with the company. He has headed the operation since 1952. In a reorganization of the Los Angeles plant, EARL E. BRIGHT, factory superintendent, becomes plant manager and E. GEORGE BAKER, administrative assistant to the vice president and general sales manager at Decatur, Ill., is assistant sales manager in charge of the Los Angeles sales office. Mueller has also announced the appointment of ROBERT R. LUGO JR. to cover a part of the Los Angeles area and portions of southern California extending to the Arizona and Nevada borders. JOHN T. LEAHY will now travel the southern Illinois territory.

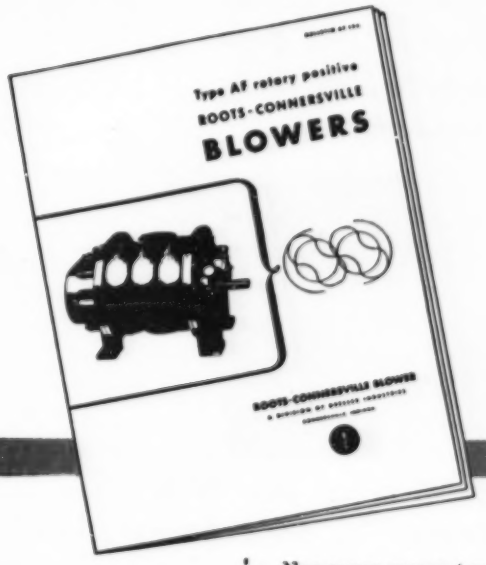
WILLIS YARD, past president of the Pacific Coast Gas Association and a former vice president and chief engineer of Pacific Gas & Electric Co., is convalescing from a recent operation. Mr. Yard is now associated with the American Liquid Gas Corp. of Los Angeles, and is in charge of the company's San Francisco office.

J. G. MONTGOMERY JR. has been elected president of United Natural Gas Co., Oil City, Pa., succeeding H. S. ROSE, who has retired. Directors include LEIGH A. BROWN, Mr. Montgom-

Willis Yard
Algas

J. G. Montgomery
United Natural

Send for new information on R-C Rotary Positive Blowers



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2. High efficiency—low operating cost
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4. Freedom from oil or oil vapor contamination

Check your present blowers and if they don't measure up, it may be an economy to replace them with modern R-C equipment.

For your present needs, or for future reference, you'll find highly useful information on the smaller sizes of Roots-Connersville Rotary Positive Blowers in this new Bulletin No. AF-154.

Especially important are the tables showing sizes, pressures, capacities and other characteristics to help you select blowers for specific applications.

You'll also find included factual data which points out why R-C Blowers meet the "BIG 4" essentials of successful performance.

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Positive Displacement Meters . . M-152
Gas Pumps (small) 31-B-17
Gas Pumps (large) 32-33-B-13
Spiraxial Compressors. SC-354
Vacuum Pumps 50-B-13
Inert Gas Generators 100-B-14
Rotary Positive Blowers (large sizes) . . RB-254

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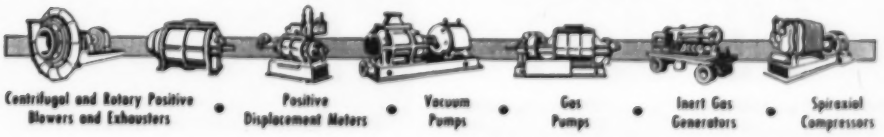

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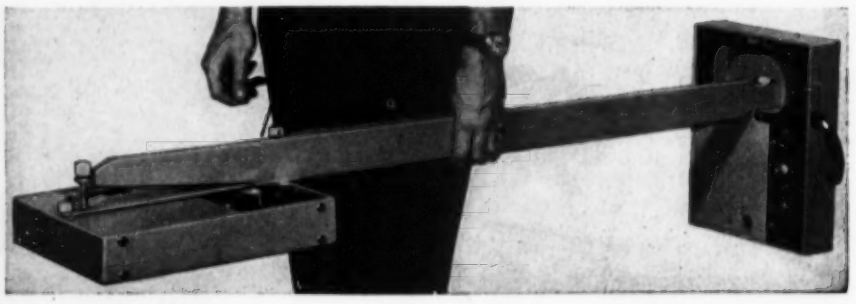

The dependability of the Wilkinson Line Locator is amply attested by its wide use. Leading gas, oil and pipe line companies generally KNOW its value.

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COLUMBIA, SOUTH CAROLINA

people • *Continued*

ery, JOHN A. COMET, HARRY B. WOOD, and HOWARD C. ROSE. The following officers have been elected: L. A. BROWN, Comptroller; J. A. COMET, vice president; H. B. WOOD, vice president; H. C. ROSE, secretary and treasurer; F. P. GINKEL, assistant secretary and assistant treasurer; F. F. THURSTON, assistant secretary; L. J. FLECKENSTEIN, assistant treasurer; and C. P. GARVEY, purchasing agent.

CHARLES S. MITCHELL has been named manager of all transportation facilities of Cities Service Oil Co. with headquarters in New York. Formerly, he was manager of the crude oil supply and transportation division in Bartlesville.

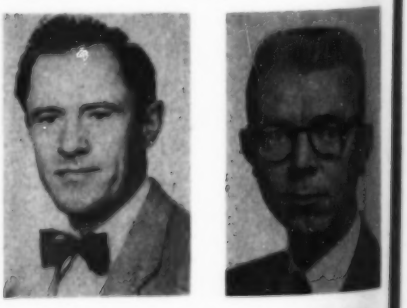
C. L. HIGHTOWER has been named to the newly created position of consultant on employee relations for United Gas Corp. and R. L. CONWAY JR. has been made safety director.

N. W. Rowand P. A. Mankin
Rockwell

The meter and valve division of Rockwell Manufacturing Co. has announced the following promotions: NORMAN W. ROWAND, general manager of the Pittsburgh division, to assistant to the vice president; PAUL A. MANKIN, chief engineer of the local division, to general manager; and ARTHUR W. KRAUSE, assistant general manager, to factory manager.

New faces

THOMAS M. RAGLAND has joined Pipe Line Anode Corp., Tulsa, as chief engineer of the company.



A. W. Krause
Rockwell

T. M. Ragland
Pipe Line Anode

DAVID L. ARM, dean of the school of engineering at the University of Delaware, has been appointed manager of the industrial department of the National Safety Council.

RICHARD WHITNEY has joined the Day & Night division of Affiliated Gas Equipment Inc., Monrovia, Calif., as product manager for water and space heating equipment.

CHARLES H. ROSE has joined Payne Furnace division, Monrovia, Calif., as branch manager of the new Houston factory branch and office.

New members of the board of directors of Arkansas Louisiana Gas Co. are RAYMOND REBSAMEN, JOE C. HARDIN, EMON A. MAHONY, and LLOYD SPENCER, all Arkansas businessmen.

A. W. ROAT has joined the Fielden Instrument division of Robertshaw-Fulton Controls Co. as field sales represensative in the northern half of Ohio and several counties in northwest Pennsylvania.

E. M. STEINMANN has joined Royston Laboratories Inc., Blawnox, Pa., as southeast sales engineer in charge of the new Atlanta, Ga., office.

Deaths

HUBERT C. BLACKWELL, former president and chairman of the board of the Cincinnati Gas & Electric Co., died recently. He was 77 years old.

GLENN C. JONES, general superintendent of Mississippi Valley Gas Co., Jackson, died recently after a brief illness. He was 56.

WARD S. PRESCOTT, president of Equitable Gas Co., Pittsburgh, from 1940 to 1950, died recently.

W. PAUL JONES, 53, vice chairman of the board of directors of Servel Inc. died on Jan. 20. President of the company from 1949 to 1954, Mr. Jones first came to work at Servel in 1929 as educational director, was advanced to advertising and sales promotion manager, and later became assistant general manager of the commercial refrigeration division. Mr. Jones left in 1934 to join the Fairbanks-Morse Co., but returned to Servel in 1949.

MICHAEL P. NOLL, a member of the sales organization of Servel Inc. since 1933, died suddenly of a heart attack. At the time of his death, Mr. Noll was district sales manager for Servel in the Kansas City area.

How a Sherman Power Digger Does More Work in Less Time with No Standby Equipment

Nearly every department in the city of Hopkins, Minnesota, finds a use for this versatile Sherman Power Digger.

The Water Department uses the machine when cutting off discontinued service lines at the main. They dig a hole in the street (usually blacktop) 3′ wide by 6′ long by 8′ deep. The hole must be plumbwalled for minimum replacement of paving. This operation used to tie up a truck all day, an air compressor half a day, and two men with hand tools, a full day.

Using a Sherman Power Digger, they now do *three* such jobs in one day, with only one man on the digger, no truck, and no compressor, except for concrete pavement. The job goes faster because they can dig the hole, shut off the line, and backfill before the walls begin to cave. Local soil conditions formerly required cribbing many of these excavations.

If *your* work involves the construction or maintenance of underground facilities, you will profit with a Sherman Power Digger. It's compact, fast, and flexible, with low initial cost and amazing economy of operation. Write today for full details, without obligation. Ask for Bulletin No. 412.

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DESIGNED for quick, low cost trench digging for foundations and all types of service lines.

LADDER type permits efficient operation in the closest quarters and under difficult conditions.

CUTS up to 5 ft. in depth in 8" to 12" widths; 4 ft. in 14" and 16" widths; straight and clean.

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The 403 is a small, easy-to-maneuver machine for digging water, gas, sewer, building foundations . . . Low bearing electric or telephone lines and for pressure to avoid damage to lawns or walkways . . . Easily transported from job to job and will travel over almost any type ground. Digs a clean, straight-sided trench with squared corners. Complete details from your distributor.

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GAS calendar

March

2-3..PCGA Home Service Conference—Santa Monica, Calif.

4..SGA Transmission Management Conference—Shamrock Hotel, Houston.

7-9..Mid-West Gas Association—St. Paul Hotel, St. Paul, Minn.

7-11..National Association of Corrosion Engineers — Palmer House, Chicago.

9-10..PCGA Customers Service Conference—Carmel, Calif.

16-17..PCGA Home Service Conference—Santa Monica, Calif.

17-18..SGA—Jung Hotel, New Orleans. Accounting Management Conference; Distribution Management Conference; Sales Executive Conference.

21-23..AGA General Management Section Spring Conference—Hotel Netherland Plaza, Cincinnati.

23-24..PCGA Accident Prevention Conference—Santa Barbara.

24-25..NEGA Annual Meeting — Hotel Statler, Boston.

24-25..Oklahoma Utilities Association Convention — Mayo Hotel, Tulsa.

April

28-1..Western Metals Congress and Exposition—Los Angeles.

7..Southeastern Gas Association Sales & Advertising Roundtable Conference — Selwyn Hotel, Charlotte, N. C.

12-14..AGA Sales Conference on Industrial & Commercial Gas —Hotel Statler, Boston.

12-15..AGA Distribution, Motor Vehicles & Corrosion Conference — Netherland Plaza, Cincinnati.

13-15..NGAA 34th Annual Convention — Baker and Adolphus Hotels, Dallas.

14..GAMA Sixth Annual Automatic Gas Range Conference —Hotel Pierre, New York.

14..Southeastern Gas Association Supervisory Training Roundtable Conference — Wade Hampton Hotel, Columbia, S. C.

18-19..AGA Residential Gas Section, Eastern Natural Gas Regional Sales Conference—Hotel William Penn, Pittsburgh.

19-20..PCGA Distribution Conference—Phoenix, Ariz.

19-21..Southwestern Gas Measurement Short Course—University of Oklahoma, Norman.

20-22..Indiana Gas Association Annual Meeting — French Lick Springs Hotel, French Lick, Ind.

25-27..National Conference of Electric and Gas Utility Accountants — Conrad Hilton Hotel, Chicago.

25-27..Mid-West Regional Gas Sales Conference—Edgewater Beach Hotel, Chicago.

28..Southeastern Gas Association Transmission & Distribution Roundtable Conference — Selwyn Hotel, Charlotte, N. C.

May

1-4..LPGA Annual Convention—Conrad Hilton Hotel, Chicago.

2-6..AGA Industrial Gas School—Hotel William Penn, Pittsburgh.

9-10..AGA Gas Supply, Transmission & Storage Conference—William Penn Hotel, Pittsburgh

12-13..Public Utilities Advertising Association—Sheraton Hotel, Chicago.

16-18..Southern Gas Association — New Orleans.

17-19..Pennsylvania Gas Association —Pocono Manor Inn, Pocono Manor, Pa.

23-25..AGA Chemical, Engineering & Manufactured Gas Production Conference — Hotel New Yorker, New York.

June

1-2..Tenth Annual Short Course in Gas Technology — Texas College of Arts & Industries, Kingsville, Texas.

5-9..Canadian Gas Association Annual Meeting—Sheraton-Brock Hotel, Niagara Falls, Ontario.

9-10..Natural Gas & Petroleum Association of Canada — Royal Connaught Hotel, Hamilton, Ontario.

27-28..Michigan Gas Association—Grand Hotel, Macinac Island, Mich.

September

9..New Jersey Gas Association —Hotel Monmouth, Spring Lake, N. J.

GAS associations

Management section to hold first spring conference

Management development will be the theme of the first spring conference sponsored by the general management section of the AGA, according to Larry Shomaker, Northern Natural Gas Co., section chairman. The conference will be held March 21-23 at the Hotel Netherland Plaza in Cincinnati.

General sessions will be held each of the three mornings. Speakers will present subjects in seven fields: accident prevention, purchasing and stores, rates, economics, corporate secretaries, competitive services, and insurance.

William Paton, University of Michigan, will talk on "Economic Incentives in a Regulated Gas Industry" at the Monday session and F. M. Banks, president of AGA and Southern California Gas Co., will address the Tuesday general session. A panel headed by Dean Richard Donham, Northwestern University, will discuss economic phases of gas industry management.

Wednesday's general session will have talks on "Management Responsibilities in Area of Labor Relations" and "Economic Implications of Extending Fringe Benefits."

Afternoon sessions will be devoted to individual programs of the seven committees. Leon Nuhfer, Peoples Natural Gas Co., will preside at meetings sponsored by the accident prevention committee, which will hear Earl H. Eacker, Boston Consolidated Gas Co. In addition, the program will include a panel on accident prevention with representatives from the insurance, personnel, and purchasing and stores committes participating.

Subjects to be presented at the purchasing and stores committee's meetings include centralization, small purchases, material testing, stock control, selection and training of personnel, package standardization, and handling of materials.

Homer A. Severne, John Hancock Life Insurance Co., will speak on public utility financing by insurance companies at the corporate secretaries' meeting. Philip West, New York Stock Exchange, will explain the part the exchange plays in financing today's business and I. I. Gardescue will review regulation trends of the FPC. Other speakers will discuss relationships between corporate secretaries and the SEC. A panel of financial advisors and analysts will analyze annual reports.

The rate committee and the committee on competitive services will hold a joint luncheon meeting at which Walter J. Herrman, SoCal, will speak on accelerated processing of rate cases. Charles A. Ashby of Stone & Webster will talk on the value of gas service. R. S. Gillespie, Indemnity Insurance Co. of North America, will discuss excess liability at an insurance meeting.

NACE meeting will feature pipeline clinics

Persons who devote all or a major part of their time to control of corrosion on underground structures will present unique information during the pipeline portions of the technical program to be given during the 1955 NACE annual conference and exhibition in Chicago, March 7-11.

Following is a tentative outline of pipeline meetings scheduled:

Pipeline general symposium, J. W Hunter Jr., Service Pipe Line Co., chairman: "Internal Plastic Coating of Pipe-

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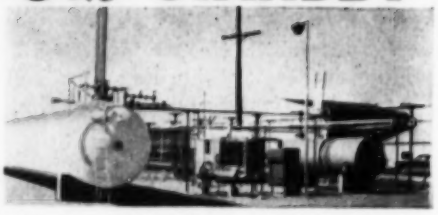

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HELP WANTED—Sales Engineer for Gas Controls. Travel Western and West Coast states from Los Angeles Sales Base contacting Engineering and Purchasing Departments of Appliance Manufacturers. Knowledge of A.G.A. requirements and Engineering education or equivalent necessary. Car furnished. Answer fully, stating work history, education, age, experience, salary expected, etc. Enclose recent snapshot. Permanent connection with growing and progressive manufacturer. Box 310, GAS, 198 So. Alvarado, Los Angeles 57, Calif.

DISTRIBUTION ENGINEERS

A prominent midwestern utility has immediate need for Gas Distribution Engineers. Must be a college graduate with experience in distribution engineering and operations. Your reply should include age, experience and salary requirements. All replies will be held confidential. Box 35, GAS, 198 S. Alvarado St., Los Angeles 57, Calif.

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HELP WANTED—Sales Engineer for Gas Controls, Chicago or vicinity sales base. Travel Mid-Western and Southern states contacting Engineering and Purchasing Departments of Appliance Manufacturers. Knowledge of A.G.A. requirements and Engineering college education or equivalent necessary. Car furnished. Answer fully, stating work history, education, age, experience, salary expected, etc. Enclose recent snapshot. Permanent connection with growing and progressive manufacturer. Thermac Co., 800 E. 108th St., Los Angeles 59, Calif.

associations • *Continued*

lines in Place," by J. C. Watts Jr., Humble Pipe Line Co.; and a discussion of the Committee T-2D report, "Proposed Standard Method for Measuring Electrical Conductance of Coating on Buried Pipelines," by L. F. Heverly, Buckeye Pipe Line Co.

Pipeline Problem clinic, R. L. Bullock, Interstate Oil Pipe Line Co., and Lyle R. Sheppard, Shell Pipe Line Corp., chairman and vice chairman, respectively: Cathodic Protection clinic, Charles L. Woody, United Gas Corp., discussion leader; internal corrosion clinic—pipelines and storage tanks, Ivy M. Parker, Plantation Pipe Line Co., discussion leader; protective coatings clinic—pipelines, L. A. Hugo, Phillips Petroleum Co., discussion leader.

On Friday, March 11, a roundtable on pipeline and underground corrosion will be held.

In addition to pipeline meetings, there will be 37 technical papers on non-pipeline subjects in nine symposia, a general corrosion roundtable, and three educational lectures.

Current-operating-problem panel set for NEGA meeting

The annual meeting of the New England Gas Association will get under way March 24 at the Hotel Statler in Boston. Two panel discussions will highlight the two-day meeting. Election of officers will also be held.

On Thursday afternoon the panel will be a discussion of current operating problems. Moderated by John A. Weiser, executive vice president of the Newport Gas Light Co., the panel will cover such subjects as reduction of unaccounted-for gas, gas conditioning, appliances

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servicing, and standby and peak shaving. Panel members include Michael Anuskiewicz, Brooklyn Union; Claude S. Hazel, Philadelphia Gas Works; Charles E. Utermohle Jr., Consolidated Gas, Electric Light & Power Co. of Baltimore; Edward F. Kennedy, New England System gas division; and John L. Turnan, Worcester Gas Light Co.

Friday afternoon's panel will be on current sales problems, covering the commercial, industrial, and residential fields. J. J. Quinn of Boston Consolidated is moderator. Members are Donald K. Smith, Rochester Gas & Electric; William J. Schmidt, Long Island Lighting; Gardner L. Bristol, Greenwich Gas; J. J. Fahey, Haverhill Gas Light Co.; and Gordon G. Howie, Cambridge Gas Light Co.

Gas price problem will highlight TIPRO meeting

A natural gas forum, in which Texas independent producers and royalty owners will discuss bills in both the Texas legislature and Congress dealing with the gas price problem, will dominate the opening session of the Texas Independent Producers & Royalty Owners Association's ninth annual meeting March 27-29 in Fort Worth.

Plans for the convention, which will attract approximately 700 independent producers from all parts of Texas, include a party Sunday evening at Hotel Texas headquarters, and an opening breakfast in the Keystone room. A ladies luncheon in the Keystone room will be conducted simultaneously with a luncheon for the men at convention headquarters Monday.

Gas to play supporting role at Metal Congress

Gas utilization and technical matters pertinent to the gas industry will occupy major supporting roles when the Ninth Western Metal Congress & Western Metal Exposition opens a week-long run in Los Angeles March 28.

A session of the Industrial Heating Equipment Association, being held March 31 in conjunction with the congress, will feature a talk on "Gas Combustion Theory and Equipment," by Arthur B. Wilcox, vice president of Eclipse Fuel & Engineering Co., Rockford, Ill. Other discussions in this meeting will cover atmospheric furnaces, and induction heating for surface hardening and brazing and for heating and forging.

A session presented by the same group on Wednesday will deal with

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PRESSURE FITTING
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Telsco Long and Short Couplings, Adapters, 90° Elbows, and Tees, ½ through 2 inches.

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At the factory every Telsco Fitting gets a 90-pound air pressure test, under water—assuring a sound casting every time.

Telsco Fittings do not insulate. Instead they conduct static electricity without the time, effort and cost of bonding every connection.

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LOWEST COST TRENCHING FOR PUBLIC UTILITY WORK

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Trenches Any Depth to 36"

For low-cost general light trenching. Self-contained, operates under its own power. Digs clean, even trenches to 36" depth. Lightweight, mobile, low operating and maintenance costs. Easily transported from job to job. Several models.

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*Originator of Vegetation Surveys for Gas Companies in 1934

furnaces for heat treating aluminum and magnesium, for annealing and billet heating, induction heating of billets, bright heat treatment for stainless steels, and heat treating titanium.

The American Society for Metals, under whose sponsorship the heating programs will be presented, will also have its own sessions, and on Tuesday the morning topic will be "New Metals in the Petroleum Industry." That afternoon, a panel will be held on "High Strength Steels."

Also participating in the Congress will be the American Welding Society, whose program will include consideration of research, welding of pressure vessels and piping, and inert gas welding. The Society for Nondestructive Testing will also convene, with important topics on the agenda including magnetic and penetrants applications.

AGA honors Carl Wolf with testimonial dinner

The board of directors of the American Gas Association late in January tendered a testimonial dinner to H. Carl Wolf, who resigned recently as managing director of the association because of illness.

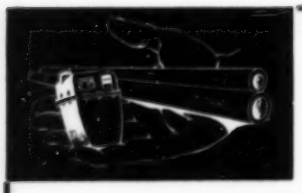
AGA directors paid tribute to H. Carl Wolf (left foreground) with a testimonial dinner. A color TV set was presented to him.

Mr. Wolf was elected managing director in October 1945. Before his election he was president of the Atlanta (Ga.) Gas Light Co. and had served as president of the Mobile Gas Service Corp. and Florida Public Utilities Co.

As its managing director, Mr. Wolf played an important part in the development of the American Gas Association. He initiated meetings with regional and state associations for discussion of mutual problems and programs. He encouraged the adoption of intensive programs of public safety and accident prevention. He was largely responsible for the continued acceptance and expansion of the gas industry's Promotion, Advertising and Research (PAR) program.

With the tremendous increase of the importance of the natural gas branch of the industry, separate manufactured and natural gas departments were eliminated. A general management section was organized to bring unity and better association representation to many general committees of AGA. The by-laws and constitution of the association were revised under Mr. Wolf's direction to bring them in line with the present day operations and activities of the association.

Mr. Wolf also took a major role in the formulation, presentation and adoption by a major part of the industry of the Gas Industry Development Program.



SHORT CUTS IN MATERIALS HANDLING: **8**

Straddle carrier

Speedy Ross Series 100 Carrier, a straddle-carrier long proven in lumber and dock-side handling operations, moves a 27,000-lb load of 30-ft joints of 13-in. OD steel pipe smartly along to demonstrate the reason for the increasing acceptance of this type of carrier in gas industry pipe yards and general pipe handling work. Photo courtesy of Industrial Truck Division, Clark Equipment Co.

Midwest gas men to gather for 50th annual meeting

Midwest gasmen will gather March 7-9 at the Hotel Saint Paul in St. Paul, Minn., for the 50th annual meeting and convention of the Mid-West Gas Association.

On the business side, convention-goers will hear a discussion of the new gas range developments by Edwin L. Hall, AGA; merchandising water heaters, by C. H. Wilkinson, Affiliated Gas Equipment; effects of atomic weapons on gas distribution, by R. C. Lisk, Fisher Governor Co.; L. P. gas promotion and its relation to the gas industry, by Kenneth R. D. Wolfe, Fisher Governor; incinerators as load builders, by George E. Marble, Michigan Consolidated Gas Co.; and FPC regulation of the natural gas producer, by Samuel B. Pettingeill, Pure Oil Co.

In addition, the manufacturers and their representatives will sponsor a cocktail party on Monday evening and the annual banquet and entertainment will be held Tuesday evening, March 8.

GAS

MARCH 1955

Several types of detectors, employing varying energy sources and several types of generating systems, are on the market, and an understanding of their theory and design is necessary if the pipeliner is to make an optimum choice and utilize them to their best advantage.

Selecting a holiday detector

By **JOHN RASOR** • Tinker & Rasor, San Gabriel, Calif.

All steel pipe that is buried in the ground is subjected to corrosion by galvanic action of the soil. From the beginning of the pipeline industry engineers have been constantly seeking methods to protect pipe from this corrosive action. The most effective method of preventing corrosion is that of coating the pipe with an electrically nonconducting material, which is usually a coal tar or asphaltic material. The properties of these materials and many others are such that they have very high electrical resistance compared to the metal pipe upon which they are placed. This electrical property makes possible a method of locating faults in the application of the coating by recording a substantial difference in electrical resistance at any point from the surface of the coating to the metallic pipe.

The development of holiday detectors began in late 1929 or early 1930. Since that time the development has been constant with the advent of new coating, coating application methods, and the trend toward larger pipe diameters.

TO PROPERLY evaluate a holiday detector for a specific application, it is necessary to know the basic electrical properties of the high voltage generating system and also to be acquainted with its limitations. The electrical load presented by the pipe to be inspected is the type of load which affects the peak voltage of the detector. A typical load *(Fig. 1)* is that of a fixed capacitance between the inspection electrode and the pipe, shunted by a variable resistance representing the leakage losses, and this network in series with a second variable resistance and variable capacitance representing the resistance and capacitance of the return to the pipe.

Capacitance variation

The capacitance of the electrode varies only with the pipe diameter, configuration of the electrode, and the coating thickness. Leakage losses develop from moisture on the surface of the

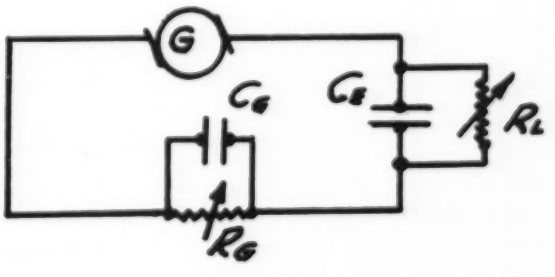


Fig. 1. Equivalent electrical load of a typical holiday detector

G = high-voltage generator

C_e = electrode capacitance

C_g = ground wire capacitance

R_1 = leakage resistance

R_g = ground resistance

About the author

Mr. Rasor is secretary-treasurer of Tinker & Rasor, manufacturers of electrical instruments. He has BS and EM degrees in mine engineering from the Missouri School of Mines & Metallurgy and is a member of the AIME and NACE. For the past five years he has been active in the electrical design of holiday detection systems.

coating, reduced electrical resistance of hot coating, and corona losses. Leakage losses are high in applications where felt outer wrappers are used, particularly in humid climates, and they are relatively low where kraft paper or no outer wrapper is applied.

Severe losses

Of the losses mentioned, the most severe are those that occur from the use of felt wrappers. These wrappers contain fibers of organic material, and although they have been impregnated to some extent, they absorb moisture and present a heavy load to high voltage. The addition of whitewash on the outer wrapper, which is commonly used in the West, increases these losses, as this material usually contains calcium and sodium chloride, both of which are hydroscopic.

The ground resistance includes the resistance from the ground wire through the earth to the pipe. This resistance varies over a considerable range, depending upon the type of ground and whether or not a connection has been made from bare pipe to the earth. Capacitance of the ground wire to the pipe varies with the distance of the wire to the pipe, and the distance of the pipe to the ground. Ground resistance can be practically eliminated by making a direct connection from the detector to the pipe; however, in practice this is usually not feasible except in yard coating operations. In arid regions of the West and Southwest, the ground over which the trailing wire must pass is usually very dry, and the resistance becomes exceedingly high.

• Energy source

ALL high-voltage generating systems require a primary electrical energy source. This source is either from dry batteries, storage batteries, portable gas-driven generators, or from ac mains. In pipeline construction work, the primary energy source must always be of portable nature. Early holiday detectors used dry batteries for primary energy. This source of energy has the advantage of light weight at rather low cost; however, dry batteries have a relatively high internal resistance, and as they are used the voltage output will decline, which in turn affects the output voltage of the generator in the same relation.

After a used dry battery source is allowed to rest without load, the voltage will rise to that of a nearly fresh battery, then decline even more rapidly as the load is sustained. This means that the high-voltage generator will not have a constant high-voltage output.

Lightweight storage batteries were developed during the war, and are now almost a standard primary power source for portable holiday detectors used on transmission line construction work. A storage battery has a very low internal resistance and as the storage battery discharges, the terminal voltage under load will decline very little until the battery is almost discharged, and consequently the generator will maintain good output regulation. The initial investment of this energy source is high in comparison to the dry batteries, but the fact that they can be recharged offsets the initial cost.

Storage batteries

Lightweight storage batteries are made in clear plastic cases and are provided with visual charge indication so that they can be properly maintained. These batteries are also made in a spillproof design so that no electrolyte can escape from the container. The most commonly used battery of this type has a capacity of approximately 22 amp hours at one amp and weighs 10 lb.

Gasoline engine-driven ac alternators are sometimes used for primary power sources, particularly where battery recharging is not possible. These alternators deliver 110 volts ac at approximately 500 watts output, and are quite heavy and require platform mounting on a cart so they can be moved along the pipeline.

• High voltage generating systems

THERE are three distinct types of high voltage generating systems currently being used in commercially available holiday detectors. They are:

(1) Alternating current
(2) High voltage direct current
(3) Pulse

Of these types the pulse and dc systems are available in small lightweight units adapted to ride on top of the pipe or be carried by the operator with a shoulder strap. These types are limited to a primary power source of a small lightweight storage battery of the type previously described.

Early types of holiday detectors, and many which are still used on small diameter pipe, use a dry battery power source, an interrupter, and a high ten-

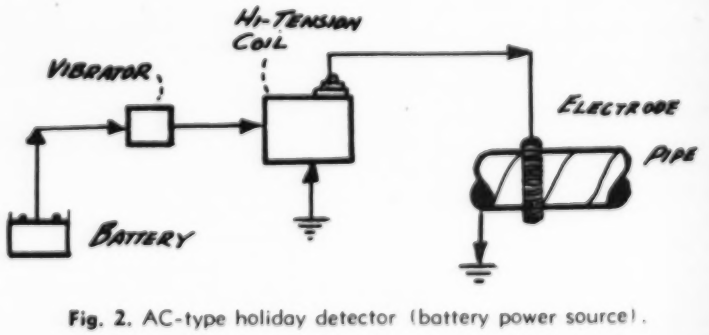


Fig. 2. AC-type holiday detector (battery power source).

sion spark coil similar to a Model "T" Ford coil *(Fig. 2)*. These coils are usually equipped with an interrupter which is actuated from one end of an open core, and the frequency of the interrupter may vary from 50 to 300 cycles per second, depending upon the adjustment of the vibrator points.

From a given battery input the peak voltage output of the coil varies over quite a range with the adjustment of the vibrator points. The wave form analyses of these coils show that high peak voltages are developed in a damped alternating current form, but the high peaks are of very small power and as soon as a small load appears on the output, the peak voltage drops rapidly. This voltage drop is very noticeable when a small capacitance appears in the load circuit, as would be developed by an electrode on the coated pipe. Leakage losses also seriously affect the peak voltage of these generators, so that a small amount of dampness will limit the output voltage to a point where no inspection may be possible even on relatively small pipe diameters.

Inoperative

A spark coil generator is practically inoperative with an electrode of high capacitance such as a full circle coil spring on moderate-size pipe diameter. An exception to this is the "somastic"-type coating, where the capacitance is relatively small because the electrode is removed from the pipe by approximately ½ in. Considerably more power output from a spark coil can be obtained by using a separately driven interrupter. The output power of an impulse type coil for a given input depends to a certain degree on the length of time in which the vibrator contacts are closed so as to allow the maximum amount of flux to build up in the coil before the points open. Independently driven interrupters will also maintain a constant frequency which aids in maintaining better voltage regulation of the coil output.

A gasoline engine-driven alternator will supply a considerable amount of energy to a high voltage transformer, and this energy is used in an attempt to minimize leakage and capacitance losses on a coated pipe. The output of the alternator is usually a 60-cycle sine wave, and with this wave form high voltage, low power peaks are eliminated. Most high voltage transformers used in this service are of a neon type which are so designed that they will supply not more than 30 milliamperes maximum, and their output voltage regulation is poor for moderately high loads. This type of generator is also furnished with an adjustable auto transformer on the primary to adjust the high voltage output of the secondary.

Output voltage affected

Although as much as 500 watts of power is available from these detectors, leakage and capacitance losses do affect the output voltage under severe conditions. With large diameter pipe and coil spring electrodes a very large amount of current flows through the coating, which in turn affects the output voltage of the transformer. This effect can easily be seen by noting the amount of voltage rise for a given input when the connection between the electrode and the generator is broken. Peak voltage from these generators reaches crest value 120 times a second with 60-cycle generators, so that an electrode can move along the pipe rapidly without passing over a holiday. Weight and mobility are problems with this type of high voltage generator.

High voltage generators

DC high voltage generators *(Fig. 3)* of the portable type consist of a storage battery primary power source, an independently driven interrupter, impulse-type coil, and a high vacuum filament-type rectifier, either with or without an internal capacitor for energy storage. The advantages of the dc high-voltage generator are threefold. With the rectifier cathode above ground all of the capacitance losses in the load are eliminated, as the electrode charges to peak voltage and no more current flows from the generator except that which is lost because of leakage. Ground resistance problems are for the most part eliminated, as very little circulating current flows through the system during inspection, and resistances of several megohms have no effect on the high voltage at the electrode. With very low leakage losses, the inspection electrode becomes a reservoir for dc energy, and peak voltage is maintained constantly so that very rapid movement of the

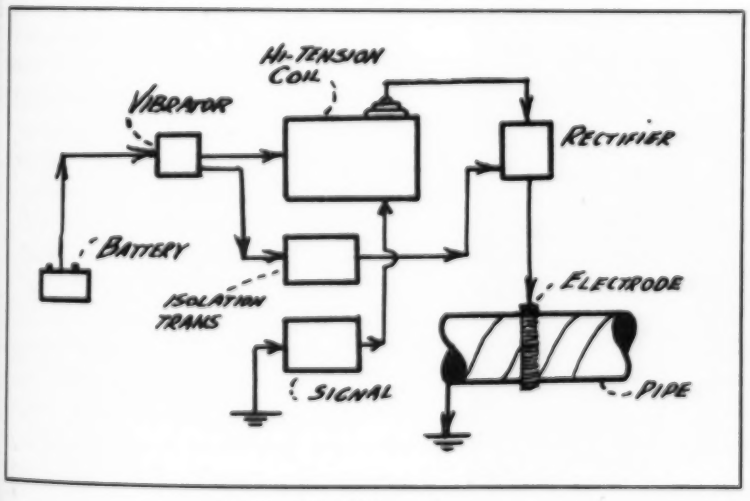


Fig. 3. DC holiday detector.

Shoulder pack holiday detector. Voltage range: 2000 to 20,000 volts. Operating weight: 16 lb.

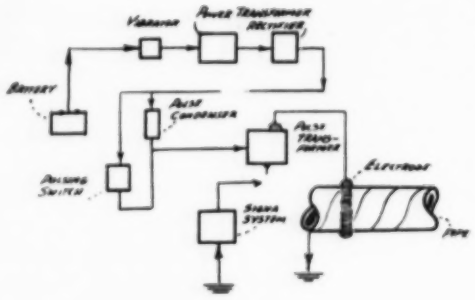


Fig. 4. Pulse detector.

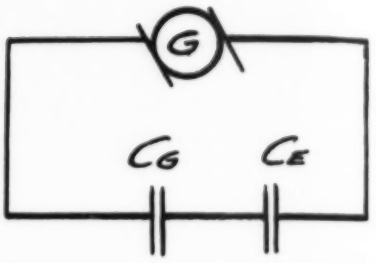


Fig. 5. Equivalent electric load of two-electrode holiday detector Ce = capacitance of test electrode. Cg = capacitance of coupling electrode.

electrode is possible. DC energy also has a less detrimental effect on coating breakdown and generally a third higher voltage can be applied to a given thickness of coating without breakdown than can be applied with ac energy.

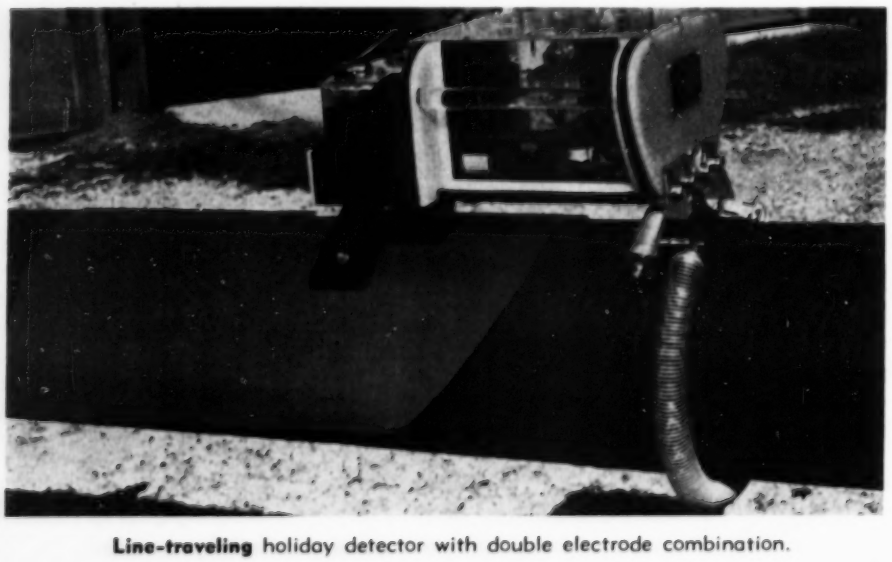
The limitation of a dc detector is that of poor regulation from leakage losses. If leakage losses are not high, a dc high voltage detector is capable of very effective electrical inspection, particularly where ground resistances are high. With the rectifier cathode at ground potential, some ac component appears in the output; however, somewhat better regulation can be obtained with this system where leakage losses become relatively high.

Pulse generators *(Fig. 4)* are a class of high voltage devices, which, during an interval of time, store electrical energy in a condenser. During the charging cycle, the condenser is disconnected from the load; then this stored energy is released into the load circuit. The characteristic of pulse energy is such that the load receives a very high power surge for an exceedingly short period of time. This device makes it possible to develop high instantaneous power output from a low average input source. By this method, a small storage battery furnishing 12 watts continuously can be made to develop as much as 20 kilowatts at 15,000 volts for approximately 8 microseconds.

Several types of pulse generators are used for portable holiday detectors. They generally consist of a small storage battery for primary power and a vibrator driving an intermediate power transformer, the output of which is from 300 to 3000 volts. The output of the power transformer is rectified and the dc then used to charge a condenser. The charged condenser is then discharged to a pulse transformer through a vibrator, rotary gap, or vacuum tube, depending upon the potential of the dc supply and the design of the system. The wave form from this type of generator will depend upon the dc voltage applied to the pulse transformer; the voltage determines the design of the transformer and the amount of inductance required to produce the necessary step up in voltage. If the dc supply voltage to the pulse transformer is low, high turns ratio will be required and the wave form will be that of damped ac of short duration. If the dc supply voltage is high, a small turns ratio is required and the wave form is that of a substantially uni-directional pulse.

Because of the limited size and weight of the primary power source in portable detectors, the input current to the pulse generator must be relatively small in order to maintain sufficient battery reserve. The rate at which the pulses are generated (at a given output voltage) is directly proportional to the input current so that good design is required to obtain maximum pulse rate with minimum input current.

The enormous amount of instantaneous power from each pulse is sufficiently high to offset leakage losses on the coating. As an example, a pulse generator will show no noticeable peak voltage drop on a pipe with a wet coating, and for all practical purposes the normal leakage losses can be disregarded with this system. Capacitance of the electrode may or may not affect the peak voltage of a pulse generator. There are pulse generators in commercial detectors that have an excess of 20,000 volts peak potential with no load and will drop to about 10,000 volts on large



Line-traveling holiday detector with double electrode combination.

diameter pipe. Assuming that the pulse generator has good regulation to capacitance loads, this regulation will not be sustained when pure resistance is placed in series with the generator. If it was for resistance alone, a pulse-type holiday detector would be inoperative with a trailing ground wire. A pulse detector will operate and sustain high enough peak voltage for good holiday detection because there is always some capacitance between the ground wire and the pipe. The amount of effective capacitance that the ground wire has to the pipe will change with the length of the ground wire, the total length of electrically connected pipe, the distance of the pipe from the ground, and the location of the ground wire from the pipe.

Recently a development has been made in the method of coupling a high voltage pulse generator to a pipe which has eliminated the conventional ground wire return system. This method has several very important advantages as will be appreciated from the foregoing discussion. The method consists of adding a second electrode from the high voltage return to the detector, which has a relatively higher capacitance to the pipe than the capacitance of the inspection electrode to the pipe. The inspection electrode and the trailing electrode in effect can be considered as two capacitors connected in series across the high-voltage generator *(Fig. 5)*.

A basic electrical law recites that when two condensers are connected in series across an electrical generator of varying potential, the total potential of the generator will be divided across each condenser in inverse proportion to their capacitance. Applying this law to the method described, it is possible to design a system where nearly all of the generator voltage can be applied between the test electrode and the pipe, and a small portion between the pipe and the trailing electrode. This, then, becomes an operative system for detecting holidays on coated pipe. The double electrode method has the advantage of eliminating the ground return through the earth and with a given set of electrodes the inspection potential will remain substantially constant at all times. If the area of the trailing electrode is large with respect to the test electrode, a small change in area of the trailing electrode will have little or no affect on the potential of the test electrode. In field use, this system eliminates the problem of adequate coupling of a pulse detector to a short length of coated pipe, which is the case where isolated sections are being inspected. Aside from the electrical benefits of this method, the elimination of a bothersome ground wire has a distinct advantage to the operator of this device.

• What is the proper voltage?

A SUBJECT of great controversy in electrical inspection is always, "What is the proper voltage to apply for testing?" In all probability, an ideal inspection device would locate the exact position of every point at which a discontinuity existed in the coating. The purpose of the coating on the pipe is to prevent corrosion, which, we understand, is the passage of small electrical current from the pipe to the surrounding earth. If the discontinuities in the coating are those that allow current to flow from the pipe to the earth, then the ideal inspection device may be one that will locate every point on the coating where current may flow from the pipe to earth, or every point of low electrical resistance.

From a practical standpoint, a well-designed holiday detector applying high potential electrical energy to all surfaces of a coated pipe will fulfill this objective. However, to give visual indication to the operator of each point of low resistance, a potential is necessary which will cause a spark to jump from the test electrode through the path of low resistance to the pipe. The potential required to do this must be high enough to break down the resistance of the air for at least the thickness of the coating.

Most present-day hot-applied coatings are of a minimum of 3/32 in. in thickness, and the required minimum potential may be in the order of 10,000 volts. At these potentials a stress is placed upon the coating so that in areas where the coating is very thin, the material will be dielectrically stressed to the point of physical rupture. This then means that the holiday detector may not be the ideal inspection device, as it will, in addition to locating points of low resistance, locate and break down coating of thin sections. In practice, an electrical holiday detector, aside from locating low resistance particles, almost always breaks down some coating material each time a spark jumps from the electrode to the pipe. It is unlikely that holidays located with a spark detector have a free and unrestricted path from the surface of the coating to bare steel.

The ideal coated pipe would have a coating of a given thickness at all points on the surface of the pipe, all of high electrical resistance and other properties which are required of coating material. In practice this cannot be attained with coating machines which apply hot bituminous coating material.

Manufacturers of coating material usually specify the electrical potential that can be applied to a given thickness of coating before it will rupture. However, it is important to analyze these specifications as they may apply to the operation of a holiday detector. Values are usually given in volts per mil of thickness. These values are determined by applying a constant voltage of a sine wave form to a specimen of coating in increasing voltage increments for a given time until the material breaks down. As previously mentioned, only one type of holiday detector applies a true sine wave form of energy, and all detectors constantly move along the coated pipe so that the electrical energy is applied at each point on the coating for a very short period of time. The dielectric breakdown is a function of time as well as applied potential, so that actually the breakdown effect of the holiday detector at a given potential is far less than the rated dielectric strength as specified by the manufacturer. It was pointed out in the discussion of high-voltage generators that the pulse-type detector produces a potential of very high power, but as it required power plus time or energy to stress dielectric material, the time of application of the individual pulse is exceedingly short and, consequently, its energy is small.

As an inspection device, the holiday

Continued on page 134

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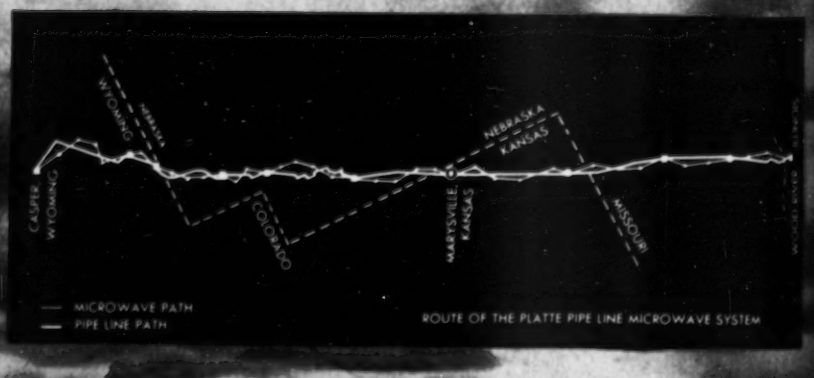

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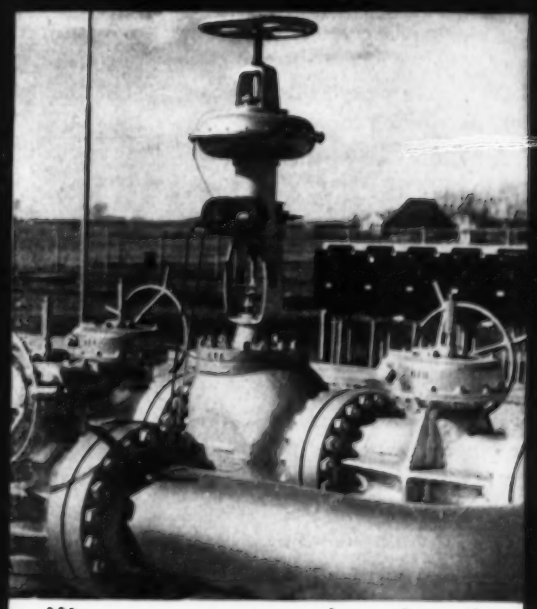
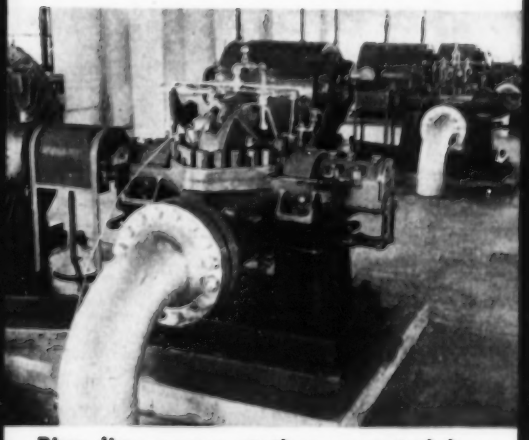


Microwave operates valves along the pipe line.



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Selection of a holiday detector ...

detector may fail to meet the critical demand for an ideal device for coating inspection; nevertheless, its ability to point out the locations of thin sections of coating is valuable. Certainly a pipe to be coated with 100-mil coating, but having points where the coating is only a few mils thick, could hardly be expected to be corrosion-free once it was buried, for a slight tension of soil stress would open a path of low resistance from this point to the ground. And, furthermore, very thin sections of coating might not be free from moisture absorption.

A holiday detector performs another important function on pipeline coating work. A coating machine applying hot bituminous material operates under conditions of many variables, and as the machine moves along the pipe cumulative deficiencies can and do accumulate in its operation so that, if no inspection is being made as a control procedure, long lengths of pipe can be coated with very little material without being detected. This is particularly important where an outer wrapper is applied over the coating and visual inspection is impossible.

A condition exists on pipeline construction work that seems unique. A holiday detector that is locating what the applicator decides is too many holidays is immediately condemned as being "too hot" and burning up the coating. In many cases this condemnation is accepted and is supported in view of the argument that patching all the holidays located slows up the job. This may have some logic, in view of the fact that there are seemingly no industry-wide standards of peak voltage to be applied to a given coating, and few methods of accurately determining peak voltage are available in the field. However, it is difficult to accept this reasoning unqualifiedly, considering the inspection methods used on other construction work.

A rather simple test can be made in the field with any holiday detector to determine if the detector is breaking down an excessive amount of good coating. The detector can be moved to a portion of the pipe which is bare and some of the coating material applied to the bare pipe in several thicknesses. A connection can be made from the detector with a probe which can be placed on the material and the potential then applied at one point for a period of time longer than would ordinarily be applied by the detector passing over the coating. If the detector does not rupture coating of a thickness considered by the buyer to be adequate for good corrosion prevention, it can be considered to be locating only very thin sections. The answer to the question of what voltage should be applied to the coating is therefore a question for the buyer to answer for himself when he determines the minimum thickness of coating which he considers to be adequate for prevention of corrosion of the buried pipe. Certainly this decision should not be made by the manufacturers of the holiday detector.

Recently a formula has been suggested as a guide to proper value of maximum peak voltage applied to coatings from a holiday detector:

$$V = K\sqrt{T}$$

Where

V = Peak voltage in kilovolts.

K = A constant with values from 1 to 1.5 depending upon type of coating.

T = Thickness of bonded coating in mils (not including wrappers).

The above formula applied to a 3/32-in. coating with constant of 1.25 would indicate proper voltage application of 12,100 volts.

• Holiday detectors in the field

IN THE foregoing discussion many technical aspects of holiday detectors have been discussed. The pipeline inspector need not be concerned about all of these details, provided he has in mind a few fundamental principles and uses good judgment in their application. It is important for the inspector also to know what type of high voltage generator is being used on his job. Some basic rules can be formulated for the following commercial detectors:

AC generators driven by gasoline engines. It must be remembered that these devices possess a large electrical energy source, and that the total energy at peak or near peak voltage is high and, hence, will have a greater electrical stress on the coating than other commercial detectors. The electrode should not be allowed to rest on the coating for a long period of time when the power is applied. Because of the high energy of these detectors, additional precautions must be taken against accidental contact by the operator of the energized electrode. Ground resistance or return to the pipe is of minor consequence, but leakage losses from hot coating material will drop the peak voltage. Many of these detectors have a voltmeter in the primary of the power transformer which will reflect a proportional load on the secondary and can be used in some measure to check output voltage variations.

High-voltage dc detectors. The use of this type of detector is limited only with respect to the amount of leakage losses present on the outer wrapper of the pipe or on hot coating material. Felt wrappers are a source of considerable leakage and operation of these detectors on damp coating should be avoided. Ground return resistances are of little consequence, and capacitance losses of the electrode may be considered small even on large pipe diameters. Peak voltage is applied almost constantly, permitting rapid inspection. Voltage checks on the electrode can be made with high resistance dc voltmeters.

Pulse detectors. The limitations of a pulse detector are threefold, i.e., ground return coupling, rate of pulse repetition, and capacitance losses. In no instance should a pulse detector be used to inspect an isolated length of pipe without a direct ground except where a double electrode unit is used. In any operation, close coupling is required between the pipe and the ground wire to approach rated output voltage. Pulse detectors have a rate of pulse repetition from 15 to 40 pulses per second, and as the pulses occur for a very short duration there is no inspection potential between pulses. It then follows that for good inspection the rate of travel along the pipe should be at the slowest practical

Continued on page 136

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Selection of a holiday detector ...

speed of travel to keep up with the coating operation.

Pipeline construction is a rough operation, and speed is of the essence. Rough handling of all equipment seems to be the accepted procedure on this kind of construction work, with seemingly unnecessary abuse to the equipment. A holiday detector is an electrical instrument and should be handled as such. A good deal of the abuse of these devices on a construction job may result from the fact that operators are unskilled laborers with little or no idea of the limitations of the device they are using, or of how it should be properly used.

A holiday detector should never be left on the pipe unattended, even for an instant. It should be removed from the pipe and placed off the right-of-way on a board or box, not in the dirt and mud. Electrodes, ground wires, and batteries should be kept free from dirt and coating material. Batteries should always be kept fully charged and not left in a discharged condition. All elements of the instrument should be placed in the shipping case in their proper place when the detector is in transit.

When voltage checks are made the electrode should be in place on the coating and the indicating device connected between the electrode and bare pipe, and not between the electrode and the ground wire. If a connection to the ground wire is made, the indicating device does not record losses in the ground return system .

• Other applications of detectors

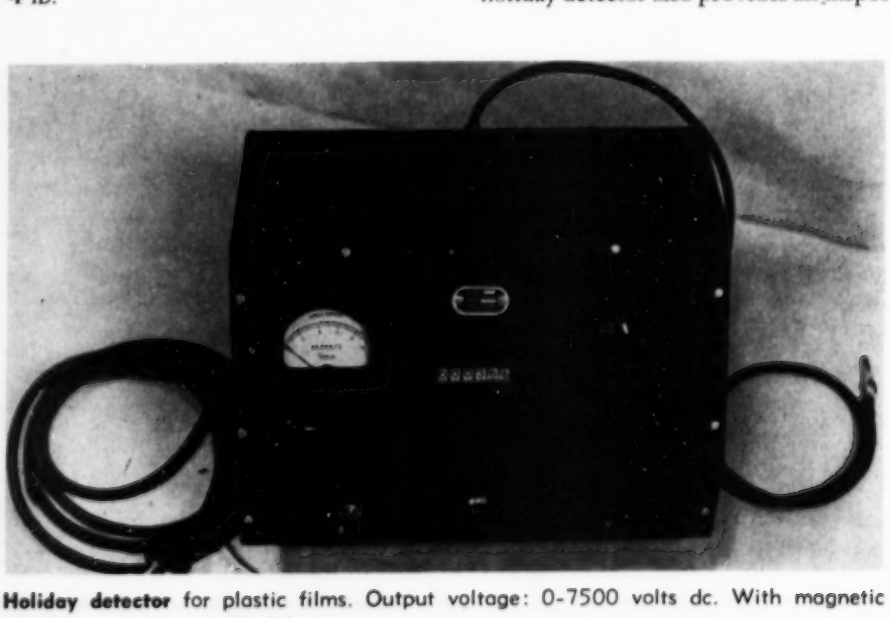
A HOLIDAY detector can also be used to advantage in the inspection of applied coating on other surfaces. For these applications, the dielectric strength per mil of thickness, nominal thickness of application, and electrical resistance of the coating material should be known.

Recently a small detector has been marketed for thin-film applications on metal or concrete surfaces. The detector applies a potential of 67 volts dc. The electrode for this application is a cellulose sponge that is dampened with water. The sponge has the important function of applying a small liquid contact to the surfaces being tested, which makes it a very accurate device for locating pin holes and bare spots. The detector has a bell signal alarm and the total weight of the device is less than 4 lb.

Another development is a detector with an adjustable dc power source from 0 to 7500 volts output, equipped with a magnetic counter which records the total number of spark discharges from an electrode assembly. This device is intended for use as a control or inspection tool in the manufacture of thin plastic films.

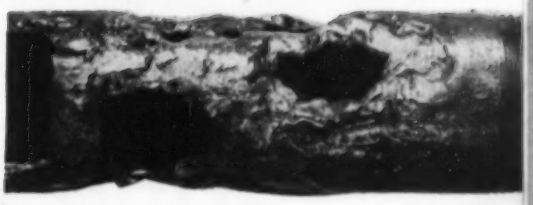
The electrical holiday detector provides the buyer of coated metallic surfaces with an inspection device, which, when properly used, locates the points of electrical low resistance or thin spots from the surface of the coating to the metallic structure. Locating and repairing these points on the coated surface before burial reduces or eliminates nearly all of the potential sources of rapid corrosion, provided the coated structure is not damaged during the laying. The holiday detector also provides an inspection device for continuously checking the application of the coating and prevents faulty coating which cannot be seen by visual inspection.

Cathodic protection to buried metal structures has been a very important and valuable economic development in the mitigation of corrosion. However, it must be realized that cathodic protection is operative only at the time and place where the corrosion reaction takes place, and if the buried structure is electrically isolated from the surrounding earth by an adequate coating no cathodic protection is required. This complete electrical isolation is not always possible in construction operations of large magnitude, but the reduction or near-elimination of low resistance paths by adequate inspection with an electrical holiday detector will minimize the amount of cathodic current required to protect a new pipeline or buried metal structure. There is no substitute for good coating. ■



Holiday detector for plastic films. Output voltage: 0-7500 volts dc. With magnetic counter to receive total holidays.

Holiday detector for thin film application. Output voltage: 65 volts dc. Operating weight: 4 lb.



The factor of soil resistivity in establishing corrosion control

By B. J. WHITLEY JR. • Tennessee Gas Transmission Co., Houston

Soluble salts, temperature, pressure, and moisture content cause soil resistivity to change constantly. Soil resistance is an indication of the corrosion rate and location, depending on relative magnitude, not absolute resistivity. The choice of sites and design of ground beds depend on the availability of low resistance soil, which definitely affects the operation and power of the beds.

ONE of the many factors that are encountered in a corrosion control program for pipelines and plant yards is the electrical resistivity of the soil. It influences the rate and location of corrosion, the sites and design of cathodic protection ground beds, the power cost of protection, and the distribution of this applied current.

Factors affecting resistivity

The most common criterion for the corrosivity of a given type of soil is its electrical resistivity, which depends largely upon the kind and concentration of salts in the soil, temperature, pressure, and moisture content. It must be remembered that these factors are changing constantly in the field.

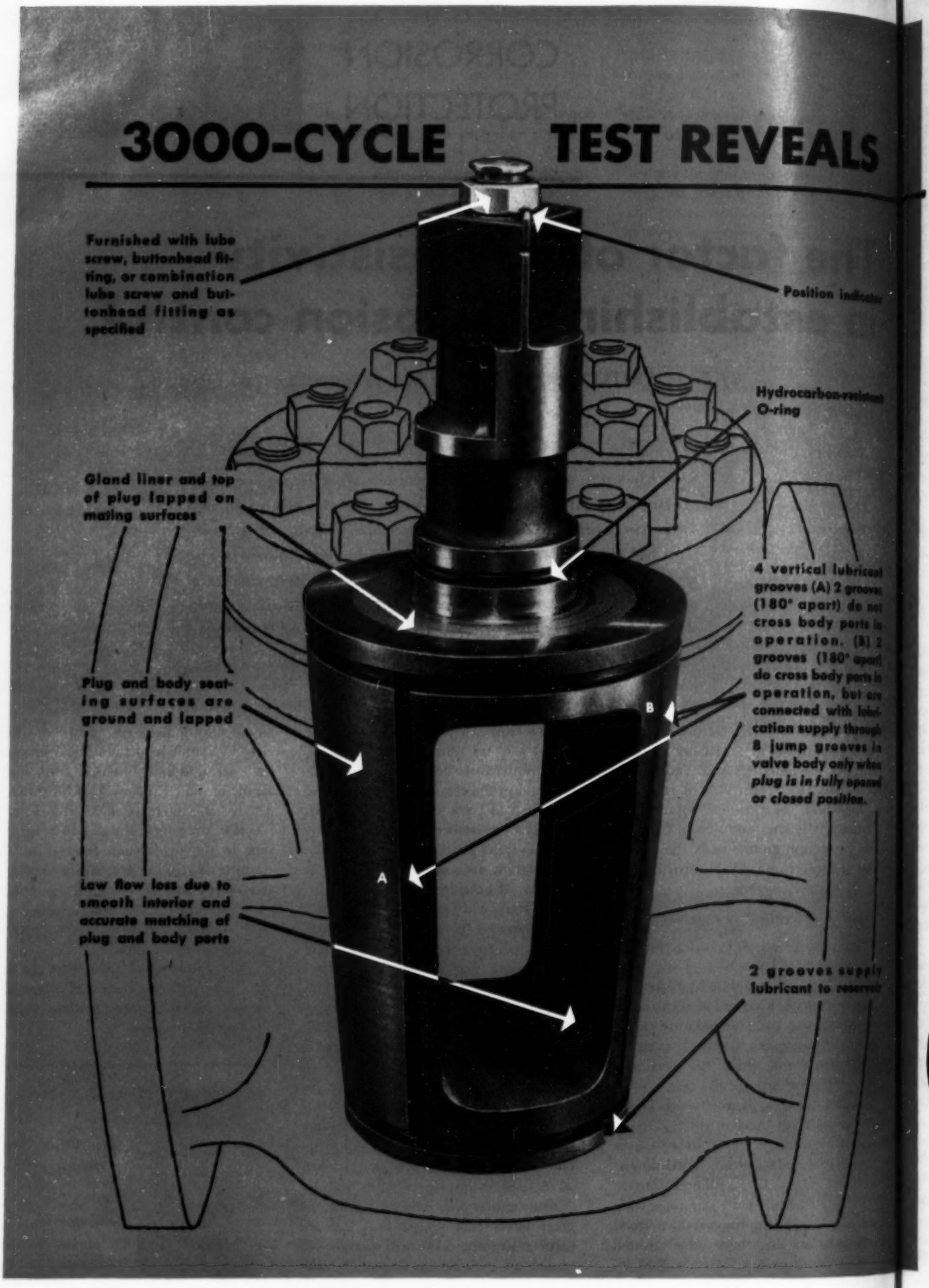
In some sandy soils, as in south Texas, soluble salts are present, yet the resistance is high when the moisture is low because the moisture is needed to dissolve the salts. This produces ions in the anode when they dry out, increasing solution, converting the soil into a good conductor of electricity. One ground bed in this area has varied in bed resistance from 0.5 to 4.0 ohms, another from 1.1 to 6.1 ohms, and it is necessary to water these beds during droughts to maintain the required output. Some soils seem to crack and pull away from the contact resistance of the anode. This becomes quite pronounced as the moisture content decreases from 20 to 5% in terms of anhydrous soil.

The Bureau of Standards circular No. C450 discusses the varied effect of pressure on soil resistivity. Tests of sample soils showed that resistivity decreased with an increase in pressure for a yellow clay, while it increased for a yellow clay with sand and a blue clay. A black humus showed very little change and a sand with humus sample decreased in resistance and then increased as pressure continued to increase. The greatest change in any one soil was the yellow clay which decreased in resistance from 2100 ohm/cm to 1810 ohm/cm with an increase in pressure to 100 lb/sq in.

The circular also shows a test of the great effect that temperature has on earth resistance. This soil sample revealed an increase in resistance from about 200 ohms at 68° F to 800 ohms at 32° F, followed by a large increase in a straight line function from 2000 ohms at 17° F up to 45,000 ohms at 0° F. This increase in resistance with decrease in temperature is quite apparent in the field when frost is in the ground. Accurate pipe-to-soil voltages are very hard to measure on frozen ground, and for the same reason it is not practical to make soil resistivity surveys in frosted ground.

The ground bed resistances do not increase greatly, however, when the ground freezes, since they are usually below the frost line.

Mr. Whitley is a corrosion engineer with TGT, working in the Texas area.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Position indicator
Hydrocarbon-resistant O-ring
Gland liner and top of plug lapped on mating surfaces
4 vertical lubricant grooves (A) 2 grooves (180° apart) do not cross body ports in operation. (B) 2 grooves (180° apart) do cross body ports in operation, but are connected with lubrication supply through 8 jump grooves in valve body only when plug is in fully opened or closed position.
Plug and body seating surfaces are ground and lapped
B
A
Low flow loss due to smooth interior and accurate matching of plug and body ports
2 grooves supply lubricant to reservoir

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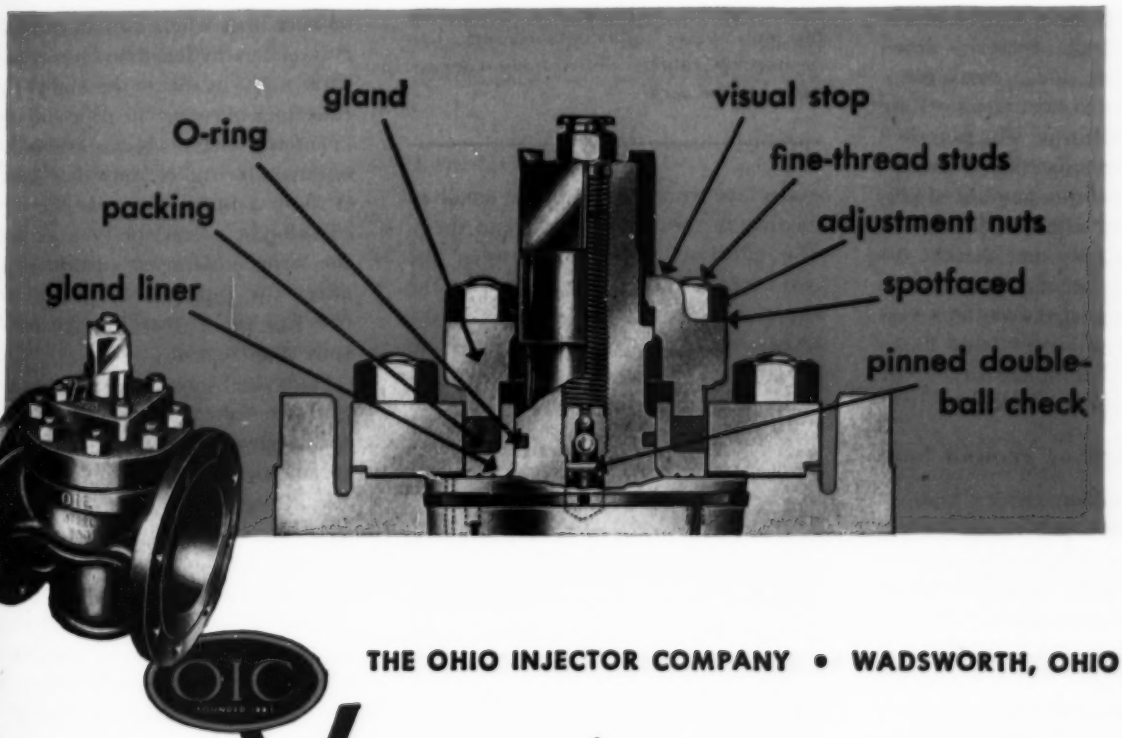

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These resistivity changes are very obvious in the field. One example is a soil sample at a particular location that, when wet after a rain, measured 1800 ohm/cm by the four-pole method using a vibroground, but measured 3900 ohm/cm during a drought. The locations of the poles were wet during the drought to reduce the contact resistance.

Corrosion rate and location

Usually it is said that the lower the resistance, the faster the corrosion rate. This is not the whole story in the field. It is true, however, that the corrosion takes place in the lower-resistance soils and the rate depends on the relative resistivity of the anodic (corrosive) area to that of the cathodic (non-corrosive) area. For cells created by differences in resistivity, the greater the difference (even though both are high) the greater the cell intensity. Corrosion will occur on pipe in 10,000 ohm/cm soil in some eastern areas, but no corrosion would be expected in that kind of soil in the Southwest. The apparent reason for this is that 10,000 ohm/cm soil could be low in relation to the average for the eastern areas, but high for the Southwest.

The terms "long-line" and "short-line corrosion cells" are sometimes used in referring to galvanic couples in lengths of several miles and a few feet, respectively. The distance between the anodic area and the cathodic area is a small factor in corrosion, and a weak long-line cell can have numerous strong short-line cells within it. The potential of the cell and the resistance of the circuit will cause a definite amount of current to flow, and the smaller is the anodic area to supply that current the faster will a leak occur. About 20 lb of steel will be corroded away in a year for each ampere of current that flows. The cathode may comprise two areas, one on each side of the anode.

Sites and design of ground beds

Cathodic protection ground beds, to be as efficient as possible, and have a low bed resistance, which would require less power, should be located in soil of the lowest resistivity available. This low soil must be prospected for at the proposed site with one of several resistivity meters that are available.

For field tests the Shepard cane apparatus and Wenner's "four terminal" method are used more than any other. Both methods are good and each has its own features. The Shepard cane is convenient to use, particularly in observing soil resistance in the pipe ditch ahead of the lowering-in gang. While it is limited to a reading of only the soil in contact with the rod, the Wenner method can be used to measure the average resistance of the soil to any depth. This is done by spacing the four terminals on the ground in a straight line even distances apart equal to the desired depth of inspection. An alternating or periodically reversed current is induced through the two outer terminals and the resulting difference in potential between the two inner terminals is observed. The depth to which the electrodes are inserted should be small in relation to the distance between them. The effective resistance between the two inner terminals is expressed by the equation $R = r/6.28a$, where "r" is the resistivity of a unit volume of soil in terms of "a," which is the distance between the terminals.

Apparatus used in the Wenner four-terminal method, including the vibroguard, the pins (lower right-hand corner), and connecting cables, which have connections for the pins.

The four-terminal method is used with the vibroground instrument and the resistivity is expressed as: $P = 191.5ar$, where

P is expressed in ohm per cubic cm
a is the distance between electrodes in feet
r is the reading of the instrument.

In prospecting for the low soil, it has been found that in some instances the low resistance soil may be traced out and then the ground bed can be designed to follow this vane.

The higher the resistivity the more anodes will be needed to obtain a low resistance bed for either sacrificial anodes or impressed current. Curves and tables are available to estimate the number of anodes and the spacing necessary to obtain a desired bed resistance in a given soil if that is the way the design is to be made. It will not help much to use a spacing of more than 40 ft and the graphite anode manufacturers recommend an output of about four amps per anode in salt water or prepared backfill installations and about one amp in fresh water installations.

Power cost

The power cost will be less for rectifiers if the bed resistance is lower, and for this reason it may be more economical in high resistance soil to spend considerable time in prospecting for lower resistivity soil. With calculations, the power output is equal to the product of the dc voltage and current in amps. A fair estimation is 50% efficiency for the rectifiers, so the dc output power should be doubled to obtain the ac power input.

Current Distribution

High resistivity soil does have one advantage. In some instances, a given amount of current seems to protect more pipe in high soil than in low, even on bare lines where current distribution is considerably less than on coated lines. This might be due to the higher contact resistance between the pipe and earth.

Interference problems are more pronounced in higher resistance soils also. If there is interference on one pipeline by cathodic protection on a second line, the same amount of current seems to affect the pipe-to-soil voltage on the first line more often in high resistance soils than in low.

This can be avoided by keeping a low uniform voltage close to 0.85, negative to the ground in reference to a copper sulfate electrode, on the second line. It would require more but smaller rectifier installations or sacrificial anodes, and would result in better efficiency since any power used to raise the voltage over 0.85 is unnecessary in mitigating corrosion. The generally accepted criterion for protection is the 0.85 volts pipe-to-soil potential. These additional units would require the initial cost to be greater; however, this is an economic problem that requires considerable investigation. ■

Hot dope hazards

Serious injuries to personnel are an ever-present danger unless extreme care is exercised in its application

By **DENNIS L. NEWBERRY** • Texas Gas Transmission Corp., Owensboro, Ky.

ACCIDENTS that may occur in hot doping are mainly eye injuries, cuts, surface burns, skin irritations, and irritation of the breathing passages.

Hot dope, or enamel, which is usually in a solid state, must be taken from the drums in which it is received and heated to a temperature of from 375 to 490° F, where it liquefies and can be applied to the pipe.

Chopping the drum open with an axe is the most common way in which the enamel is removed from the container. The enamel is then broken into pieces that can be heated in kettles. Here is encountered the first hazard—that of flying particles lodging in the eye as the can is split and the dope broken up. All personnel engaged directly in this operation and those working nearby must wear eye protection equipment.

Secondary possibility

A secondary accident possibility is that of cuts, which may be received from the sharp edges of the metal barrels. If the men cut a drum in half and transport it to the job site, this situation worsens.

To combat these cutting hazards, all sharp edges should be bent down out of the way, and all personnel involved should wear heavy gloves and, if possible, a sleeve for arm protection.

When the dope is heated to the right temperature, it is drawn from the kettle in buckets, carried to the pipe to be coated and poured onto the pipe from the top. To insure a good coating on the bottom, a "granny rag" (a piece of material either cloth, metal or paper, usually about 24 in. wide) is placed under the line with a man on either side to hold it. This rag is pulled up against the pipe directly under the spot where the dope is being poured; as the enamel runs down either side of the pipe to the bottom, the granny is pulled rapidly back and forth in a seesaw manner.

Fumes

As the dope is being applied and grannied, fumes are given off in quantity, and should the hole where the line is lying have water in it, the fumes are intensified and the men are wreathed in these fumes since there can be no wind to carry them away. These fumes, or vapors, cause skin irritation much like sunburn, and the eyes and breathing passages are affected in some degree, depending on the amount of vapor to which the individual has been exposed. To meet this hazard, which can easily result in a disabling injury, the men should cover as much of their exposed skin area as possible. Sleeves should be rolled down, collars buttoned, hats or caps and heavy gloves should be worn. Those areas that cannot be easily covered, such as the back of the neck, ears, etc., should be covered with a protective cream, and finally, a full covering face mask with an air filter should be worn by all of the people in the hole.

When applying the hot dope, men should wear adequate protective coverings.

Burn contact

Another hazard is that of actual contact burn. From the time it is drawn from the kettle until it has solidified on the pipe, hot dope is a potential trouble maker. In addition to the personal protective equipment mentioned above, the men pulling the rag should be equipped with heavy leather "spats," which can be quickly removed to protect their feet from contact burns, and, of course, the vapor protective equipment should be designed so as to prevent contact burns, should the dope splash on the men. ■

Here's the pattern for gas transmission pipeline compressor stations of the future!

Part 3 in a Series

The New Gas Transmission and Distribution Piping Code

ASA—B31—SECTION 8

A background discussion by **FRED A. HOUGH**

Chapter 2. Welding on completed pipe

CHAPTER II of ASA B31.1 Section 8 deals with welding. The investigation by Subcommittee 8 of causes for pipeline failures disclosed that failure of field welds and factory-made girth and repair welds are a more important cause of pipeline failure than many of the subcommittee members had previously thought. In fact, failures of this type constitute the most important single type of pipeline failure resulting from causes originating in the field (as contrasted to causes originating in the pipe mill).

While this record is influenced to a considerable extent by the failure of welds made by processes not now in general use, the record also shows that there has been an important number of failures attributable to welding done since World War II by the manual arc welding process.

Welding on completed pipe

Chapter II of the code and this discussion of that chapter deal only with welding on completed pipe and do not deal with the long seam welding of pipe during manufacture.

The great use of welding in the gas transmission and distribution industry and its relative importance as a cause of failure resulted in careful attention being given to this operation by Subcommittee 8. The subcommittee had in its membership or employed as consultants a number of recognized experts on welding and related metallurgical problems. Among these are Lloyd R. Jackson, Battelle Memorial Institute; Prof. Harry Udin, Massachusetts Institute of Technology; Prof. E. C. Wright, University of Alabama; and Prof. E. R. Parker, University of California.

In addition, the pipe and fitting manufacturers made some of their top metallurgists and welding experts available to the committee. Some of the major pipeline companies gave the committee the results of their recent research on welding.

Sound conclusions

These sources of information, coupled with the experience of the subcommittee members, led, I think, to some very sound conclusions by the committee concerning the cause of current welding difficulties and their elimination.

The most important basic cause is the use of welding procedures that are not suitable when unusual conditions are encountered, such as:

1. High pipe chemistry.
2. Adverse weather conditions, such as low atmospheric temperatures or wind.
3. Making of repairs to pipe or the welding of small attachments to pipe.

Other sources of difficulty have been the use in some cases of inadequate standards of skill and quality, careless workmanship, coupled with inadequate inspection, and improper design of some joints.

To proceed now to a more detailed discussion of these causes of difficulty:

The high pipe chemistry problem is one that is usually not encountered, but it can occur unexpectedly and, by virtue of its unexpectedness, cause trouble on a pipeline construction job and in the subsequent testing of operation of a pipeline.

This problem arises from the demand of the gas industry for high strength pipe and the lack of adequate chemistry limits in the API5LX specifications.

The weldability of carbon steels used in high-strength pipe manufacture is related to their carbon equivalent $(C + \frac{MN}{4})$. The chemistry limits of weldability found for ordinary field practices are variously stated by welding engineers to be $C + \frac{MN}{4} = .60$ or $C + \frac{MN}{4} = 6.5$.

The new API5LX specifications published in November 1954 contain chemistry limits for 5LX46 and 5LX52 pipe as shown in *Table 1*.

Seamless pipe on the high side of the limits permitted by this specification will have a carbon equivalent of $.35 + \frac{1.40}{4} = .70$.

Likewise, cold expanded pipe complying with this specification can have a carbon equivalent as high as $.32 + \frac{1.30}{4} = .645$.

Border line

It can be seen, therefore, that even the new specification API5LX, which for the first time imposes chemistry limits for X46 and X52 pipe, includes pipe which is on or beyond the border line of weldability by ordinary field procedures.

In order to avoid exceeding the chemistry limits imposed by the new specifications, pipe manufacturers will, of

TABLE 1. CHEMISTRY LIMITS

	Seamless		Plate Pipe Cold Expanded	
	Ladle	Check	Ladle	Check
Carbon, max.	.32	.35	.28	.32
Manganese, max.	1.35	1.40	1.25	1.30

Piping code... Rapid cooling of a weld in high-strength pipe is objectionable

course, aim at a carbon and manganese content considerably below the specified limits and only a small percentage of the total pipe produced will have carbon and manganese contents closely approaching the specification limits. However, the unavoidable variations in chemistry inherent in the pipe-making process will result in some pipe having chemistry at or near the high limits of the specification. In the field there is no way of differentiating this high chemistry pipe from the rest. If it is welded by some widely used procedures during adverse weather conditions a seriously defective weld can result.

Adverse weather

Consider now the effect of adverse weather conditions. Rapid cooling of a weld in high-strength pipe is objectionable. It causes under-bead cracking and lack of ductility. If welding is done in cold weather, the pipe welded will be cold and consequently the rate at which the weld and adjacent metal cools is high. Wind intensifies this effect.

The placing of a small weld on a large mass of cold pipe metal is bad because of the rate at which the large mass will conduct heat away from the weld. This is the reason why the repairing of defects in large pipe, either in the pipe plant or in the field, often leads to trouble. Even if the original defect, such as a crack, is completely removed by grinding, the repair weld is likely to crack because of the chilling effect on the weld of the surrounding mass of cold metal.

The making of small attachments to large pipe by welding is bad for the same reason.

Faulty design which does not prescribe smooth transition from one cross-section to another where pipes of different thicknesses are joined or where pipe is welded to a thick valve or fitting; or faulty design which results in stress concentration at a weld, all can lead, sometimes, to weld failure.

All of the causes of weld failure thus far discussed are actually the result of poor engineering and are not necessarily associated with unskilled or careless welding (although, of course, a poorly made weld is sometimes a contributing cause of failure).

Having in mind now the important causes of pipeline welding difficulties, what remedies are prescribed or recommended by the code?

Qualified welders

The code prescribes that all pipeline welding be done by properly qualified welders in accordance with a procedure that has been proven by tests to be capable of producing sound welds under field conditions.

If this is done intelligently and the procedure is followed in the field, most pipeline welding difficulties can be eliminated. Some companies who anticipate using their welding procedures in cold northern climates are qualifying their procedures by having test welds made in a cold room. The temperature in the cold room is held to the lowest temperature at which welding will be done in the field. Fans in the cold room are used to create realistic wind conditions. Pipe on the high side of the chemistry of the pipe specification is used. Welds made under these conditions are then subjected to the qualifying tests prescribed by the code. These may be those prescribed by:

ASME Boiler and Pressure Vessel Code Section IX,
ASA B31.1 Pressure Pipe Code Section 6, Chapter IV, or by
API Pipeline Welding Specification 1104.

If alloy steel base metals are involved, either one of the first two codes above must be used.

Under-bead cracking tests, although not prescribed by any of the codes, are very useful in checking the suitability of a welding procedure for use in low ambient temperatures.

Almost all procedures designed for welding in cold weather employ the hot-pass technique. This technique consists of following the stringer bead with the second pass (hot pass) as soon as possible and before the heat picked up by the pipe in the immediate vicinity of the weld has dissipated. On 16-in. pipe and larger at least two welders work simultaneously on the stringer bead and sectond pass so as to maintain as high a pipe temperature as possible.

The code points out the great value of preheating the base metal before welding when low metal or ambient temperatures exist. Preheat to 300° F has been found to be very effective. Preheating reduces the rate of cooling of a weld, thus reducing the hardening and cracking tendencies. It is essential even in warm weather when a small amount of welding is done on a relatively large mass of metal (as, for example, when a repair weld or small attachment is made).

The low-hydrogen electrode can be beneficially employed in welding procedures when the adverse effects of low ambient temperatures or other causes of too rapid cooling must be avoided. However, to get reliable results from this electrode, modified techniques must be used. The rod must be stored so as to prevent either moisture loss or moisture absorption.

The code prescribes joint designs that are free from notch effects and are suitable for field welding conditions.

The code classifies gas piping into two categories insofar as welding inspection, weld test, standards of acceptability, and welder qualification are concerned.

Hoop stress

One category involves piping to operate at a hoop stress greater than 20% of the specified minimum yield strength of the pipe, and the other involves piping to operate at lower hoop stresses.

In the former case, the requirements of any one of the three codes listed above must be followed.

In the case of the lower stress level category, into which nearly all distribution piping falls, less exacting but adequate standards are prescribed. Compliance with the new code will require that all gas distribution companies and their contractors qualify their welding procedures and their welders. Many such companies have not done this in the past.

Fig. 1. Panel of 20 lights using two-color indication at Lone Star's Springtown gasoline plant. Audible alarm is sounded by howler (background) if trouble develops at any of the 20 critical points. Relay panel (with top of explosion-proof housing removed) is visible in background.

Fig. 2. Relay panel with its explosion-proof housing removed. Panel shown is equipped with 21 relays, circuit breakers, etc., to activate 20 two-color pilot light lamps. Additional relays to serve 20 more indicators can be installed if plant expansion warrants them.

Fig. 3. Technician points with left hand to pneumatic controller used to properly position diaphragm-type motor valve. Pressure-sensitive switch (below at right) is linked with output from pneumatic controller. Switch cover can be removed to inspect or reset the point.

Audible and visual alarm system monitors critical points in process plants

A RELATIVELY simple, but experience-proven, visual and audible alarm system has been used in the process plants operated by Lone Star Gas Co., Dallas, since 1947. The latest installation of a system following the basic design of its predecessors was made in Lone Star's Springtown gasoline plant.

Heart of the system

The heart of the trouble-detecting system is a centrally located panel board equipped with the necessary number of explosion-proof pilot lights with either two- or three-color lamps (*see Fig. 1*). Each two- or three-color pilot light gives an indication of the operational state of a process being carried out at some remote point in the plant. If the process at each point monitored is normal, all white pilot lamps are energized. Should the property being observed (pressure, temperature, liquid level, etc.) at any monitored point vary in excess of preset limits, the pilot light representing that point on the panel board displays either a green or red light, and a howler is activated.

A red lamp lighted on the panel board indicates that the property has exceeded the maximum limit of its preset range and, conversely, a green lamp lighted indicated that the minimum limit of the range has been passed; that is, red indicates "high" and green indicates "low."

The panel board can be constructed with a single or double face to permit observation from either side or from both sides simultaneously. The lamps are normally clearly visible from distances up to 150 ft away, so the plant operators need not remain in the immediate area of the panel board. Also, the howler will draw their attention from a considerable distance; for periods when the plant or portions of it are off-stream, a switch can take the howler out of the warning circuit.

Improper functioning

When the pressure, temperature, liquid level, or other property sensing element indicates the process is functioning improperly at a particular point, a correlated mercury switch is activated to turn off the white lamp and turn on either the green or the red lamp. This is accomplished with appropriate circuitry through relay equipment.

The relay equipment used at the Springtown plant is shown in *Fig. 2*. This panel has 21 relays, circuit breakers, etc., and is sufficient to handle 20 pilot lights with two-color indication. The capacity of the relay board can be doubled if future expansion makes this necessary. Each function is independent of the others.

Hazardous locations

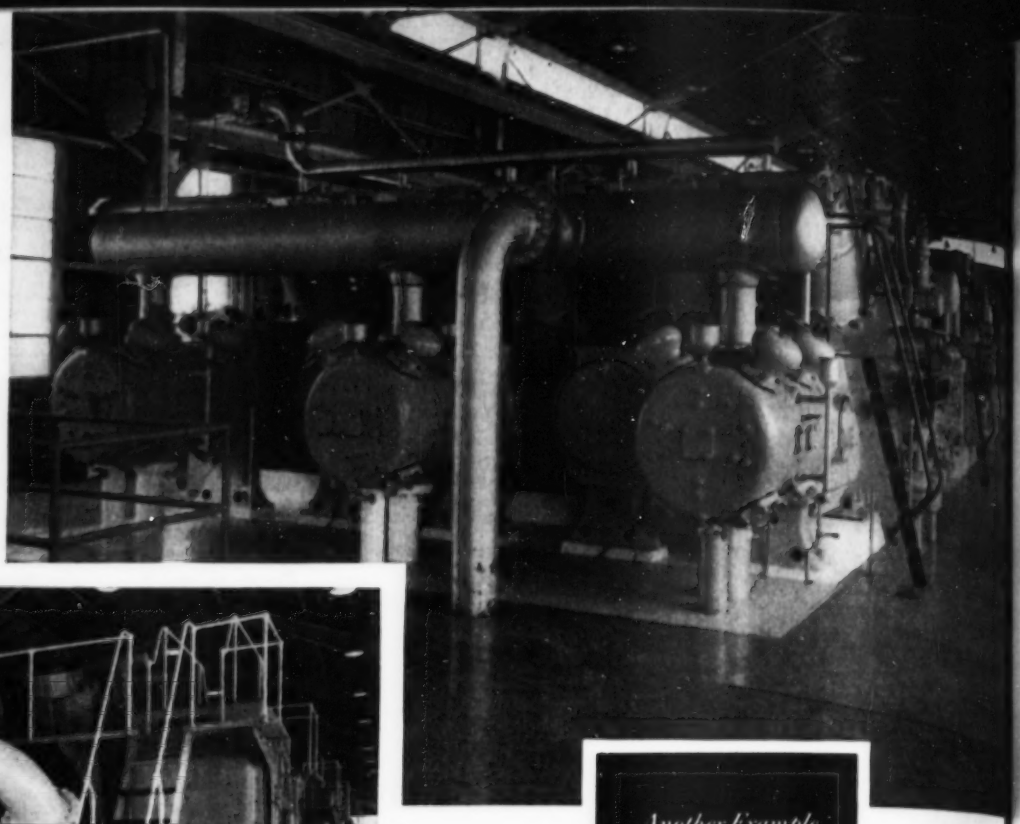
The design of the relay housing permits it to be mounted in hazardous locations and all lead wires are terminated in 36-point plugs for quick removal of either one relay or the entire panel. The latter is secured to the interior of the case with four bolts. If a single relay needs replacement, this can be done with or without removing the entire assembly.

Some of the sensing and controlling mechanisms are shown in *Fig. 3*.

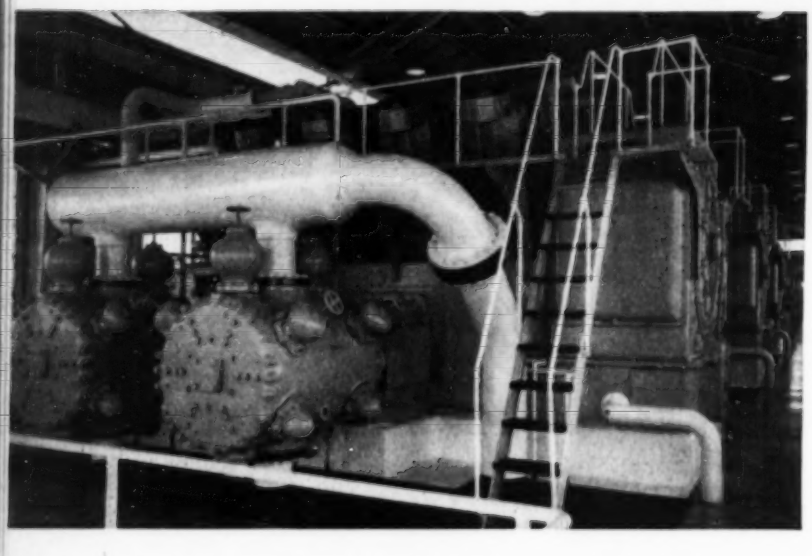
These lighted panel boards allow operators to keep critical points in the process flow system under observation without time-consuming tours around the plant. ■

Adapted from *The Blue Blaze*, published by Lone Star Gas Co. Dallas.

Shown here are a few of the twenty-nine GMV's at the Batesville, Miss., station of Tennessee Gas. In addition to these 1000 hp Cooper-Bessemers, there are three 8-cylinder, 2000 hp GMW's — all delivering gas in volume well above their performance guarantee.



Close-up of the compressor cylinders on one of the three 2000 hp GMW V-angle units in operation at the Portland, Tenn., station of Tennessee Gas Transmission. A total of thirty Cooper-Bessemers comprise this large installation.



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Orifice Meter Plates, T. K. M. Smith, *Nov., p. 46.*
The Effect of Water Vapor Upon the Measurement of Gas Under a Vacuum, P. W. Hill, *Dec., p. 52.*
Methods Used in Computing Orifice Meter Charts; The Square Root Planimeter, R. F. Angell, *Dec., p. 53.*

1930

Meter-Reading Education for the Consumer: An Effective Good-Will Gesture, J. C. Barnes, *Jan., p. 32.*
Positive Displacement of Dry Gas Meters, Otto Goldkamp, *March, p. 43.*
Measuring Gas Flow Under Varying Pressures with the Chart-Rim Planimeter, T. F. Falls, *March, p. 45.*
Pressure and Meter Controlled Area in Gas Distribution, M. J. Cereghino, *June, p. 44.*
Gasoline Plant Metering, N. C. Wells, *Aug., p. 43.*
Largest Orifice Meter Station for Arkansas Natural Gas Corporation, W. R. McLaughlin, *Aug., p. 45.*
Field Service and Maintenance of Orifice Meters, D. A. Stocks, *Sept., p. 196.*
The Meterman's Equipment, J. A. Swindle, *Oct., p. 48.*
Correcting for Temperature in Large Volume Positive Displacement Measurement, H. M. Crawford, *Nov., p. 46.*
Gas Flow Temperature Through Orifice Meters, Maris Levering, *Nov., p. 47.*

1931

Orifice Meter or Displacement Meter, F. H. Winslow, *Jan., p. 42.*
Handling Large Industrial Meters, W. Musgrave Wood, *Jan., p. 48.*
Classification of Continuous Flow Gas and Liquid Meters, W. H. Davis, *April, p. 44.*
Measurement of Non-Viscous Liquids by Orifice Meter, William L. Cowan, *May, p. 62.*
Accuracy Expectancy in Orifice Meter Measurement, H. M. Dwight, *June, p. 40.*
Large Volume Measurement Stations, B. G. Williams, *July, p. 43.*
Industrial Applications of Meters, E. M. DeRemer, *Aug., p. 158.*
Measurement of Gas at High Altitudes, Ralph L. Cook, *Sept., p. 40.*
Convenient Charts for Flow of Gas Under High Pressure, Frank Wills, *Nov., p. 18.*
Recording Instruments in Gas Measurement, W. C. Begeebing, *Nov., p. 38.*
Problems of a Meter Engineer, Roy M. Bauer, *Dec., p. 38.*
Gas Measurement in the Metric System, W. P. Porcher, *Dec., p. 40.*

1932

Eliminating Pulsation Errors in Orifice Meter Measurement, *Jan., p. 38.*
Factors Affecting the Test of Meters, John E. Naylor, *Feb., p. 38.*
Orifice Plates for Definite Base Coefficients, M. W Adcock, *March, p. 40.*
Metering Installations in Northern California, *April, p. 37.*
The Motion and Measurement of Fluids, George Sidney Binckley, *May, p. 54.*
Training and Functions of a Field Meterman, E. E. Stocall, *June, p. 34.*
Ambient Temperatures and Gas Measurement, C. E. Pickup, *July, p. 32.*
The Metric Wide-Range Orifice, K. C. Tomlinson, *July, p. 35.*
Domestic Meters, D. E. Farmer, *Aug., p. 105.*
Natural Gas Measurement, R. L. Cook, *Aug., p. 127.*
Progress in Measurement, R. F. Angell, *Aug., p. 160.*
The Daniel Orifice Fitting, J. A. Campbell, *Sept., p. 26.*
Accuracy of Orifice Meter Chart Computations, C. D. McMartin, *Dec., p. 30.*

1933

The Economics of Removing Locked Meters, N. Hoff, *Feb., p. 12.*
Can We Improve the Domestic Gas Meter?, Lee Holtz, *Feb., p. 24.*
An Orifice Meter Delivery Chart, C. J. Brown, *March, p. 34.*
The Lucas Orifice Fitting, A. E. DeBurn, *April, p. 37.*
Unit Type Meter Houses, Gordon Greene, *June, p. 22.*
Prepayment Meters: Aid to Load Building, W. D. Dickey, *July, p. 32.*
Construction and Operation of Positive Gas Meters, W. G. Cox, *July, p. 33.*

Moisture Control for Increasing Domestic Meter Accuracy, H. M. Crawford, *Aug., p. 25.*
Large Volume Measurement, L. F. Reetz, *Sept., p. 55.*
Design of Orifice Meter Charts, Frank L. Smith and B. G. Williams, *Oct., p. 24.*

1934

Gas Measurement and Control in a Large Central Station, F. G. Philo, *Jan., p. 30.*
Integrating Orifice Meter with Electric or Gas Driven Clock, A. W. Decker, *Feb., p. 22.*
Testing and Proving Displacement Meters in the Field, W. L. Kindred, *March, p. 30.*
When Should Idle Gas Meters Be Removed? H. L. Gaidry, *Aug., p. 30.*
Recent Progress in Fluid Measurement by Orifice Meter, William L. Cowan, Part I, *Sept., p. 47.*
Recent Progress in Fluid Measurement by Orifice Meter, William L. Cowan, Part II, *Oct., p. 27.*
Selecting the Proper Meter to Measure Large Loads, James L. Griffen, *Dec., p. 32.*

1935

Static Pressure Compensator for Orifice Gas Meters, Virgil E. Schultz, *Jan., p. 31.*
Factors and Trends in Meter Maintenance, R. W. McClenahan, *June, p. 39.*

1936

Procedures Discussed for Application of New Orifice Meter Data, C. B. Heartwell, *Feb., p. 39.*
Effects of Humidity on Meter Proof, C. W. Capswell, *May, p. 77.*
Current Practice and Trends in Orifice Metering, E. H. Fisher, *Aug., p. 51.*
Use of the Anti-Orifice Meter for Field Studies of Gas Flows, Hugh E. Ferguson, *Dec., p. 13.*

1937

The Value of Meter Records in Effective Meter Control and Mainetnance, David P. Allen, *Feb., p. 58.*
The Joliet Reference Meter, C. B. Heartwell, *April, p. 67.*
Gas Company Meter Tests, H. S. Harris, *Aug., p. 77.*
The Double Orifice Meter, B. G. Williams, *Sept., p. 67.*

1938

The Measurement of Viscous Liquids by Orifice Meter, W. L. Cowan, *Jan., p. 53.*
Positive Displacement Meters for Liquids, P. W. Hill, *March, p. 59.*
Certain Recommendations on the Use of Orifice Meter Coefficients, J. B. Taylor, *May, p. 70.*
One Company's Procedure in Maintaining and Operating Orifice Meter Set-Ups, M. J. Cereghino, *July, p. 51.*
The Detection and Mitigation of Pulsation in Orifice Meters, T. K. M. Smith and R. E. Morter, *Sept., p. 55.*
The Testing of Gas Meters at Low Rates of Flow, C. W. Capwell, *Oct., p. 39.*
Field Testing of Meters with a Low Pressure Flow Prover, F. H. Winslow, *Dec., p. 21.*

1939

A Practical Flow Meter for Field Utilization, John G. Williamson, *April, p. 48.*
The Norman Meter School — A Record of Its Progress, Dean W. H. Carson, *May, p. 70.*
Effect of Pulsating Flow on Gas Measurement, S. R. Beitler, *June, p. 27.*
Advantages of an Improved Open-Top Tin Meter, H. S. Harris, *Aug., p. 30.*

1940

Calibration of Positive Meters, H. J. Sterk, *Feb., p. 35.*
The International Standardization of Constriction-Flow Meters in Europe, B. G. Williams, *July, p. 40.*
New Equipment for Meter Maintenance, Henry S. Harris, *Oct., p. 37.*
Repairing Gas Meters: A Pictorial Trip Through the Meter Shop of the Peoples Gas Light and Coke Company in Chicago, *Nov., p. 32.*

1941

Sizing Meters for Home Heating, C. A. Peterson, *Jan., p. 20.*
Modern Production of Iron Gas Meters, Allen D. MacLean, *Sept., p. 41.*
The Camera Follows a Meter Through the Shop, *Oct., p. 45.*

1942

Meter Men Present "Wrinkle Ideas", *July, p. 35.*

1943

Maintenance of Measuring Station Yards, *April, p. 68.*
Importance in Proper Chart Censoring in Gas Measurement Work, C. S. Glidden, *Aug., p. 26.*
Survey of Gas Usage in Master Metered Housing Projects in Northern California, John J. Pugh, *Oct., p. 38.*

1945

For Postwar — A Travelling Meter Shop? *Feb., p. 44.*

1946

Testing Large Capacity Gas Meters, Howard S. Bean, M. E. Benesh, and Frank C. Witting, *Sept., p. 33.*

1947

San Diego's Extraordinary Meter Repair Shop, Lauran Clapp, *July, p. 29.*
Gas Flow Meter, *Nov., p. 39.*

1948

What's Ahead — In Meters, Valves, J. A. Kerr, *May, p. 70.*

1949

Meter Performance, W. J. Menet, *June, p. 50.*
A Recommended Method for Testing Meter Set Assemblies, *July, p. 76.*

1950

More About Meters, C. W. Stewart, *May, p. 40.*
New Displacement Method for Measuring Gas Flow, J. C. Wright, *May, p. 116.*
Test Meter Method, R. Frank Nowlin, *Sept., p. 37.*
The Economics of Metering, G. K. Bachmann, Part I, *Dec., p. 34.*

1951

The Economics of Metering, G. K. Bachmann, Part II, *Jan., p. 32.*
Effects of Conversions on Meters, J. M. Pickford, *Feb., p. 25.*

1952

Recorder-Bellows Device Measures Maximum Demand, H. T. Libby, *July, p. 47.*
New Gas Meter Stop Developed by Mueller, Frank H. Mueller, *Nov., p. 49.*

1953

Analysis with Cardiographs Diagnoses Meter Problems, Ed Gilmore, *April, p. 38.*
Bureau of Standards Designs New Electronic Flowmeter, *April, p. 58.*
Progress in Large Volume Measurement, F. M. Partridge, *Nov., p. 98.*

1954

Production Line Speeds Meter Repair at Tulsa Shop, Gilbert Estill, *Feb., p. 42.*
Houston's Experience with Combination Meter Regulators, H. H. Sexton, *March, p. 39.*
Relief Valves on Customer Meter Sets, George M. Fox, *June, p. 57.*
A New Approach to Meter Design, James Webb, *June, p. 37.*
Meter Covers Gaining in Popularity Among Domestic Gas Consumers, William W. Clark, *Nov., p. 43.*
Can a Domestic Meter's Accuracy Be Improved? Ed Gilmore, *Sept., p. 42.*
A Pound of Gas, Howard S. Bean, *Dec., p. 31.*

Many factors must be considered

Methods of estimating natural gas reserves

The American Gas Association will momentarily release its annual report on the estimated natural gas reserves available to transmission companies, distribution systems, and ultimately to the gas consumers of the nation. No doubt these data will introduce a feeling of confidence and security to those who are charged with the procurement and maintenance of gas supply because the drive to drill exploratory wells and prove new areas of production has always been capable of keeping proven natural gas reserves in a very favorable position in relation to national consumption. It is pertinent to look behind the figures in the report and learn something of the scientific methods employed to arrive at them.

Ralph E. Davis, noted geologist and recognized expert on reserves, presented the methods used in his estimation of natural gas reserves at the last annual meeting of the Independent Natural Gas Association of America. Mr. Davis began his work in the reserves estimating field in 1920 and did much of the pioneering in the development of this type of study, so his review of the present methods used is worthy of study prior to the release of the reserves committee's report. This presentation is adapted from his INGAA paper.

ABOUT 30% of the known reserves of natural gas at the end of 1953 were dissolved in, or associated with, oil in producible reservoirs. This dissolved gas will be produced as casinghead gas, so the essentials for estimating in this case require the evaluation of the volume of gas in solution with the crude in the reservoir in relation to the oil, the total expected oil production, and the ratio of gas that will be produced with the oil. In addition, consideration must be given to the practice of recycling a portion of the casinghead gas by injection into the producing formation so that the resultant pressure maintenance program will result in the recovery of more oil. In short, in certain areas under this operating technique, possibly only 45% of the gas produced will ever reach pipelines. This is an important facet to the tricky game of reserves estimates; an accurate estimate will include only that gas available to transmission systems.

With non-associated or dry gas, the oldest method for judging the reserves in a new strike is by comparison with neighboring fields considered essentially similar. Here, consideration can be given to concrete arithmetic factors such as the calculations of sand thickness (the thickness of the producing formation or stratum), the porosity (relative volume of void space), connate water (water naturally associated with the crude), the permeability (the inter-connection of void spaces in the reservoir formation to form a flow path for the petroliferous materials contained therein), and the pressure and temperature. It is not well, however, to base the estimation of the reserves on these variables alone, because the production histories of production per acre or per acre-foot from older, depleted fields producing from the same sands form a very important correlation factor.

The pressure decline method

This method uses the relationship of expected production to past production on the basis of percentage pressure decline. This method should be used with care as it may introduce error if the effect of water drive is incorrectly estimated or if the effect on average pressures by the pressures of new wells is used. Actually, if a given number of acres with a given number of wells per unit-area was worked with, and the producing sand was the same thickness and had uniform porosity and permeability at each well, an average pressure graph from year to year could be easily plotted. This is the objective, but really weighted averages have been used although a reservoir does not generally display such similar continuity.

In actual production practice, greater volumes of gas are produced from the better-than-average wells, so the production is not taken from each given unit of area in proportion to its initial reserve. Therefore, the graph would show average pressure in marginal acreage for a recent year that would be higher than it would have been if the pressures of the more productive wells had been given greater weight. Mr. Davis' approach specifies an allowance for the high pressures in the marginal acreage in spite of the lowering of the abondonment pressure to that now advocated by the Reserves Committee of the AGA, that is, 25 psig wellhead pressure.

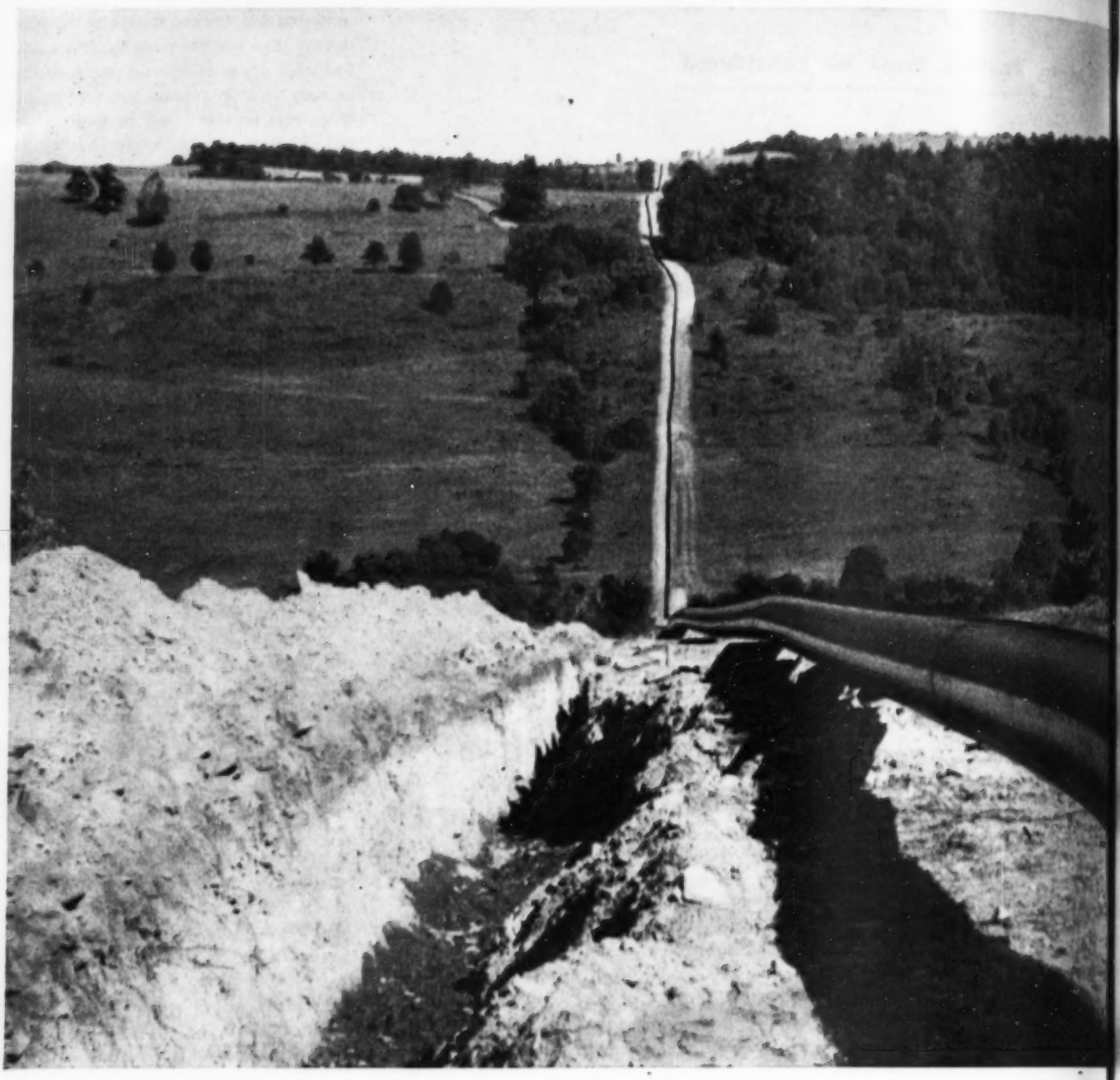
This method of estimating reserves is not feasible during the early production phases of a field; a sound trend for pressure decline must be observed before it is applied.

The volumetric method

Practically, this is the single sound method for predicting the ultimate production from newly discovered fields, and as the initial recovery phase is generally the period in which such estimates are most needed, probably 80% of all reserves estimates are computed by this method today.

With this method, it is of prime importance that the personnel making the preparations for the estimate be the type who value competence and have experience, good judgment, and are not frightened by careful study of detail. The thickness of the pay sand can be determined by drilling data, cores, electric logs, etc., from a few or many wells. If the sand displayed uniformity, these determinations would be easy, but generally, especially in deep Gulf Coast fields the fault pattern is difficult to fathom and in this case, as well as in most other cases, it is necessary to prepare a structure map of the sand or of each of several sands. It is also common practice to prepare maps in isopachous form. The isopach may be in part dependent on the structure map(s), so

(Continued on page 158)



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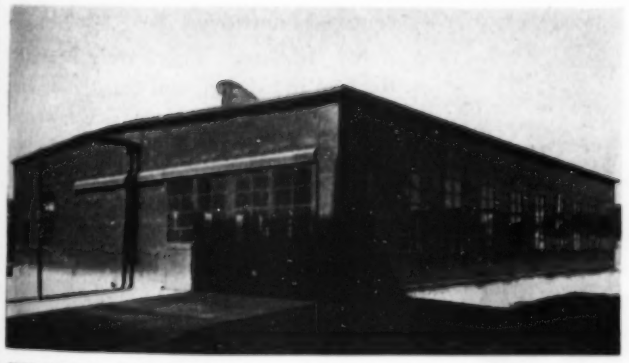

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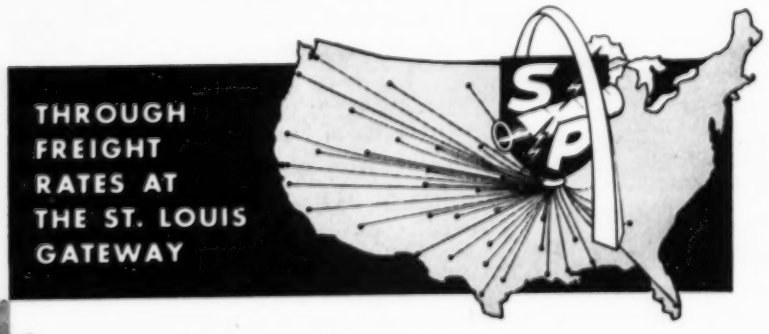

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Washington News - continued

require that "the rates and charges of natural gas companies be determined on the basis of the actual legitimate cost of the companies' property, less depreciation."

The men in Congress who believe in the producers' cause—and it is a large and growing group, including many from "consumer" states, as well as "neutral" states and "producer" states—had held off introducing the so-called "Kerr bill" this session until they could read the report of the President's Cabinet Committee on Energy Supplies and Resources Policy. However, when the issuance of this report was delayed, Mr. Rogers introduced his bill and the fat was in the fire. The actual drive to enact the legislation already had gotten under way before the introduction of the Rogers legislation, and it will pick up speed as time passes.

Even chance

There's every indication here that the drive will move forward regularly and that the legislation to free natural gas producers from federal control has a 50-50 chance of enactment, unless it is vetoed, which seems highly unlikely, in the view of many.

At the first quarterly meeting of the National Petroleum Council here, Chairman Walter S. Hallanan told a group of federal officials—mostly from Interior's Oil & Gas Division—that FPC control of natural gas production and gathering is a "toe-in-the door" approach to complete federal regulation. Government price fixing, in turn, will bring about scarcity, rationing and high prices at the consumer level, he said, adding: "That is the inevitable result when incentive is destroyed."

Mr. Hallanan, figuratively bearding the lion in his den, said that the oil and gas industry has cooperated wholeheartedly with Uncle Sam for years—nine through the NPC—but that "I think we ought to serve notice that we will fight to the last ditch against any invasion of our liberty."

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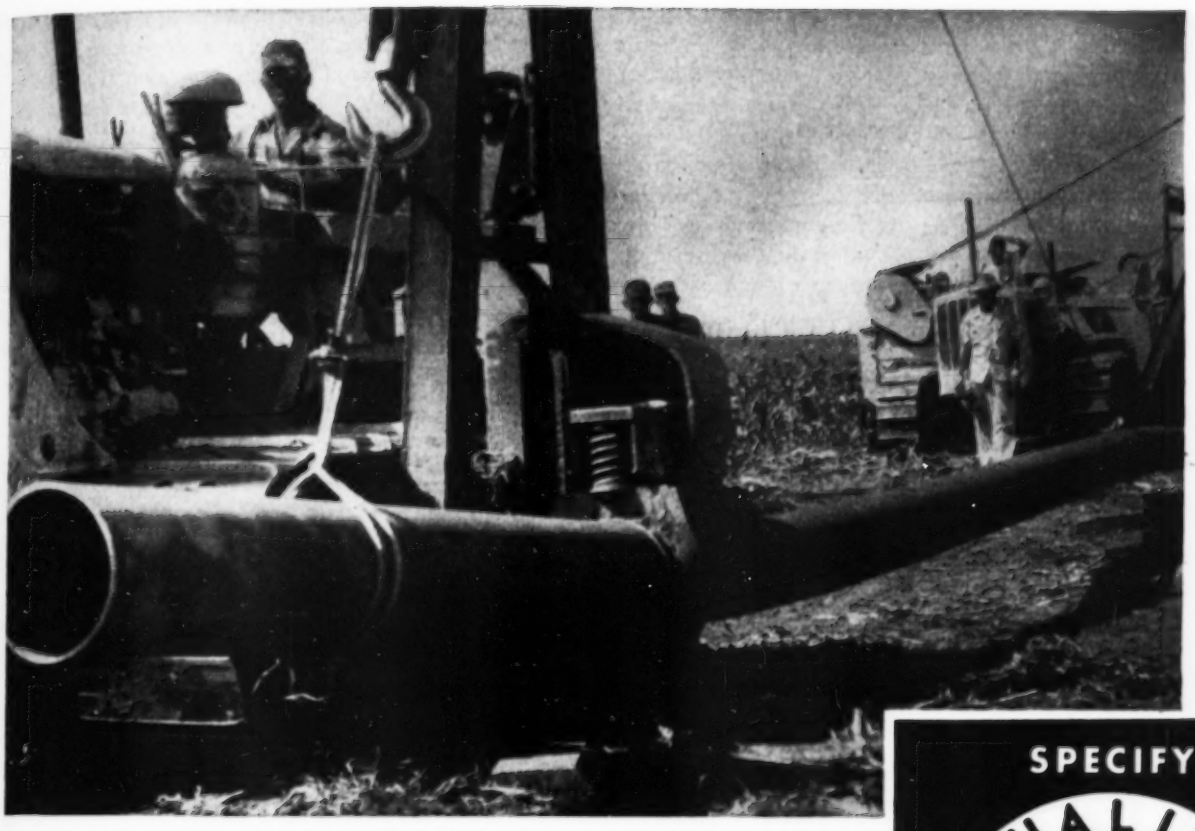

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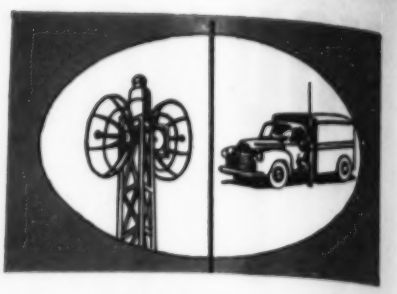


By FRANK CHAPMAN

The management view of microwave

TOO often the men who are responsible for the design and maintenance of the gas industry's communications systems are guilty of not taking what might well be termed a "management" view of their own operations. As such they are guilty not only of failing to assume a part of the responsibility they have to their jobs but also of failing to fulfill an obligation to make the fullest possible application of the technique they have so successfully developed.

That this is a natural tendency, however, is not to be denied. In the early days of pipelining the communications men, many of whom are still in the industry, were necessarily involved in the details of a new and largely untried method of communication. The long, cross-country gas pipeline was the proving ground for microwave communication and the men responsible for its operation had little time for anything else. In these days management, too, was sympathetic for there was no question in anyone's mind but that the technique was plagued with problems.

But now times have changed. Microwave has become a proven technique, most of the "mystery" has disappeared, and it is now an integral part of the pipeline industry's communications system. This may be considered a significant step forward except for the fact that, as such, microwave must now assume the responsibilities that go with any technique considered to be an integral part of the overall gas pipeline industry. This means that "reliability" and "costs" become important considerations. It also means that serious thought and consideration must be given to a continued program of "selling" the advantagees of the system to management.

Even as recently as the late 1940s, the long gas pipelines that were built through the back country of the south and southwest found no means of public communications available to them. At considerable expense, extensive private systems of wire line communication were often built to provide the need for some parallel means of handling information. However, ice storms, wind and the myriad problems of maintenance plagued the private systems. Even those public wire systems that were used were often out of service at the very time they were most needed.

It was into this atmosphere that microwave communication was born and came to find its place in the industry. The matter of "costs" and "reliability" were of no major consideration under these circumstances. The mere fact that microwave afforded a potential means of communication that closely paralleled the pipeline and was not, ordinarily, affected by weather was sufficient to sell management on the idea.

It is probably unfortunate that microwave grew so rapidly in this favorable climate. As it proved to be a worthwhile method of communication, more and more functions were heaped upon its still very inexperienced shoulders If the gas industry communications men of the early days of microwave committed any error it was an error of trying to provide too great a service with their new system.

At the moment, however, this is all a matter of history. The problem today for the communications man is how to handle microwave as an established part of gas industry operation.

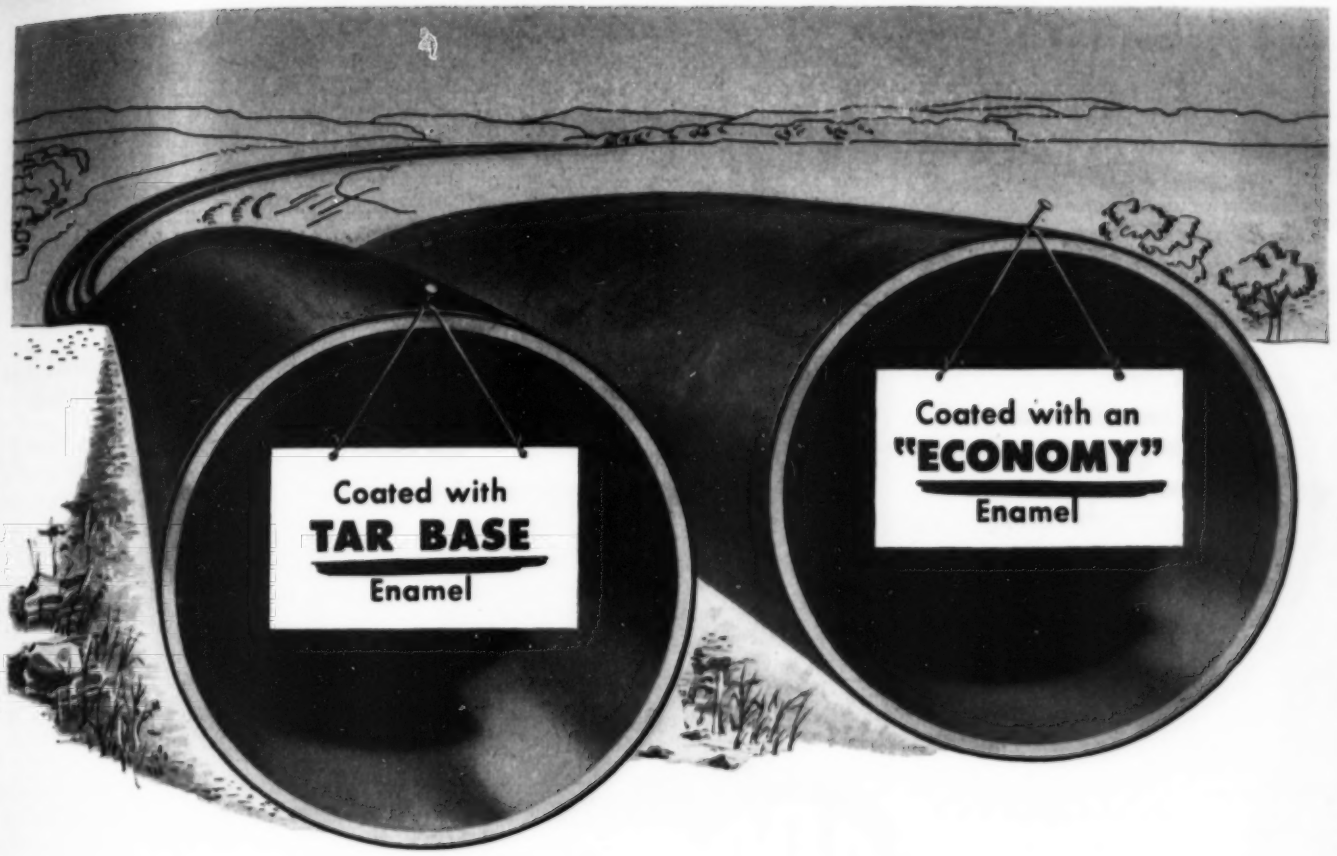
"Reliability," a major consideration in any accepted technique, is largely a matter of experience. Microwave has taken long steps over the past few years and current records show that it has gained a high degree of reliability. Continued advancement in this respect will result, as has past achievement, from on-the-job experience of men in the industry. Every day of actual operating experience adds to reliability.

Daniel E. Noble, vice president of Motorola Inc., in a talk last spring, made pointed reference to the fullest application of microwave communications. Communications men in the industry would do well to give pause to his remarks in the light of their own future.

"Point-to-point communications in the industry," he said, "is significant only to the extent that it provides improved operational efficiency. A microwave system on a pipeline, carrying instructions, general business information, and repair instructions makes a significant contribution to successful control, but this is only the first step in the utilization of a microwave system."

Making direct reference to the "management" view of the system, he pointed out that "microwave provides the basic communication means, and the full economic utilization of such a communications link cannot be achieved without integrating it into the over-all system's operational concept. "There must," he continued, "be freedom to choose the channels, codes and code characteristics required to develop automatic control."

In other words, microwave communications must be expected to become as much an integral part of a gas pipeline as the valves and regulators. And it is the duty of the industry communications men to develop these applications. They must not expect to stand still and to rest on past accomplishments, which have, in large part, consisted in the handling of oral information. The objective must now be to develop new appli-



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cations that will result in "improved operational efficiency." This is what management expects and must have from any technique that is to be an integral part of the pipeline system.

Finally, there is the matter of "costs." As the industry matures and becomes more competitive, more and more emphasis is placed on the costs of operation. This is not, of course, a trait to be considered peculiar to the gas pipeline industry. At this particular time, with the cost of transporting gas making up a substantial portion of the price to the consumer, it is especially important for the communications man to take an "economic" look at microwave. As hard as it may be for him to do, he should make an effort to put himself on management's side of the fence and from there take a long and careful look at his own operation.

He must balance the matter of costs against operational efficiency; he must look for and find applications that will increase the operational efficiency of his system and again balance them against costs; and he must take an active interest in the procedures by which his own company develops its costs. All of these matters may be strange to the communications man but they are matters with which he must acquaint himself if he is to assume his proper responsibility over what has now become an integral part of the gas pipeline system.

"Split channel" proposal has far-reaching implications

An FCC proposal for "split channel" operation for vehicular radio, originally sponsored by the Central Committee on Radio Facilities of the API, has resulted in the reopening of a historic and still unresolved conflict between the government and non-government spectrum users in the communications field. Whether or not these far-reaching implications do develop, however, the proposal does promise to considerably increase spectrum space in the Petroleum Radio Service.

The proposal would reduce channel separation in the 25-50 mc. band from 40 kc to 20 kc. and in the 152-162 mc. band from 60 kc. to 15 kc. Split Channel assignments in the latter band normally would be made only on an alternate 15 kc. basis so as to provide 30 kc. separation in the same local service area. However, the commission also invites comments on a 20 kc. assignment plan for the 152-162 mc. band, with resultant 40 kc. separation of local assignments.

Besides the new split channel frequency proposals, new narrow band frequency stability and emission standards and amortization schedules for existing equipment are also set forth.

The controversy between government and non-government services was interjected into the argument by dissenting commissioners who contended that "attempting to alleviate the congestion of channel occupancy in the non-government land mobile radio services by reducing channel spacing may serve merely to complicate further some basic problems which we are confronted with today. These problems stem principally from the fact that our present frequency allocation in these ranges provides for the intermixture of various government and non-government services without a sufficient weighing of the relative over-all public interest considerations for occupancy."

Broadcasting-Telecasting, trade journal in the communications field, predicted an over-all TV allocation threat as a possible result of the split channel proposal. Editorially the magazine said, "Fate of TV channels 2 and 6 and FM may be decided in highly technical plan-

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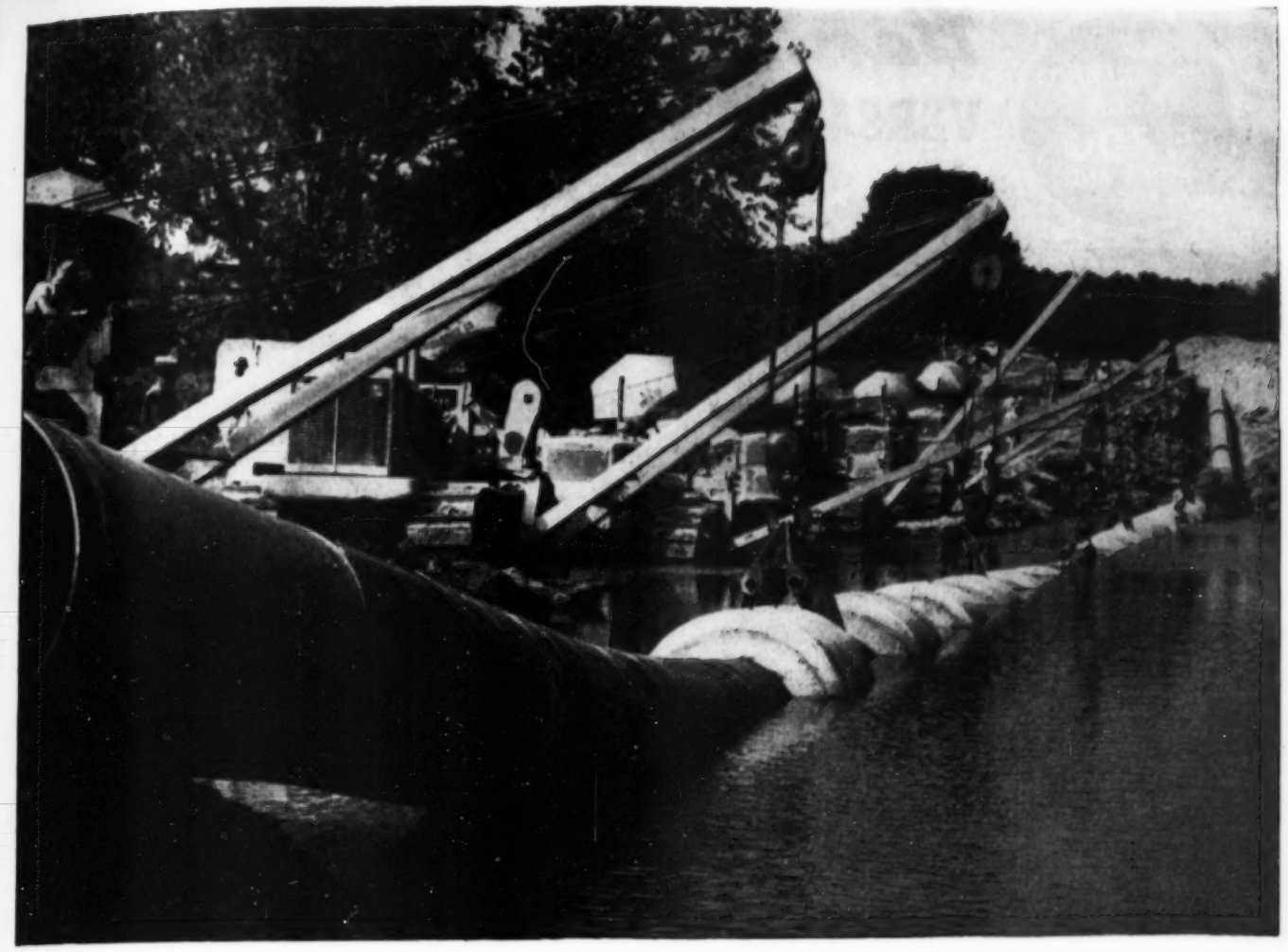

Under the Green River . . .
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communications • *Cont'd.*

ning involving the President's cabinet as well as the FCC." The magazine predicted a possible telecommunications crisis for the entire country which "at the extreme could affect even the newly reallocated TV bands (both VHF and UHF) as well as FM."

The magazine saw the possibility of a cabinet level committee recommending that the President establish the "necessary high-ranking direction in some form, especially to arbitrate—if it cannot solve—the controversy inherent in growing military demands and the equally mushrooming non-government services."

Lease-maintenance arguments heard

The discussion of industry leasing of communications facilities from common carrier companies got down to cases at the local level recently in Los Angeles at a hearing before the California Public Utilities Commission on a proposed sale, lease-back and maintenance agreement between the two southern California gas companies and the Pacific Telephone and Telegraph Co. The hearing resulted from applications by the Southern California and Southern Counties Gas companies to sell their combined radio-telephone equipment and facilities to the telephone company, coupled with an application by the telephone company to provide and maintain radio-telephone facilities and equipment for them.

The hearing was completed on Jan. 28 and no decision has thus far been forthcoming.

The matter of radio-telephone system maintenance costs on the part of both the gas companies and the telephone company, and the status of the lease-maintenance service offered by the telephone company insofar as it affects that company's so-called utility operations occupied a substantial portion of the hearing.

The latter argument was injected into the hearing in large part by the city of Los Angeles through its assistant city attorney, Allan Campbell. His questions were primarily directed toward an effort to determine what, if any, effect the change in status of the gas companies' communications facilities might have upon the rates of either the gas companies or the telephone company.

Staff counsel for the Public Utilities Commission directed his inquiry into the specific procedures by which the gas companies and the telephone company arrived at cost of maintenance figures. In his closing statement he argued that the lease-maintenance service should be considered as a utility rather than a non-utility function.

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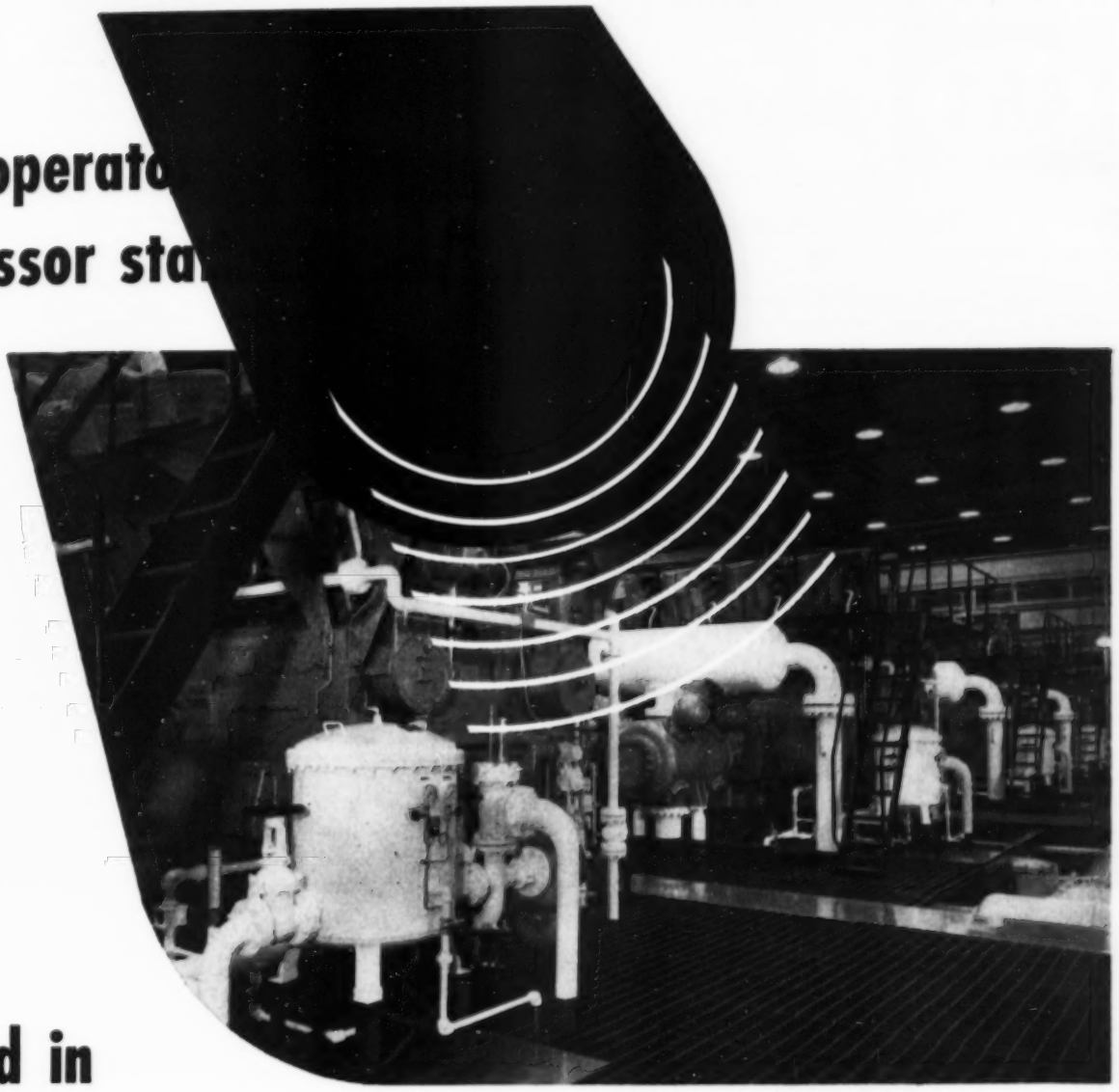

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GAS pipeline news

Pacific Northwest expands Northwest service area

Declaring that "we propose to serve every city, town, and industry within economic reach of our pipeline," Ray C. Fish, chairman of the board of Pacific Northwest Pipeline Corp., announced that his company plans to pipe gas to the Couer d'Alene and Metaline mining districts, the Columbia basin and the Lewiston area of Washington and Idaho. It also plans to make gas available to mining firms in Trails, B. C., and Moses Lake and other communities in the Columbia basin are almost certain to get gas under the expanded program. The Lewiston area will be served from a branch line to be built from the mainline.

Spokane, Pasco and other Northwest cities included in the company's original plans for serving the region are scheduled to get gas first. The other areas, including the mining districts, won't get gas until Canadian gas becomes available, which, Mr. Fish said, "probably won't be until 1957."

• • •

Meanwhile, it is reported that Westcoast Transmission Co. is already planning a second 30-in. line from the Peace river fields through British Columbia to the U. S. border, paralleling the already proposed line to connect with Pacific Northwest.

According to Westcoast's president, George McMahon, it is possible that the second line will be required by 1958 or 1960. When it is built, this will represent an investment of some $280 million in twin lines.

Montana-Dakota seeks to serve North Dakota area

Montana-Dakota Utilities Co., Minneapolis, has filed an application with the North Dakota Public Service commission for authority to construct and operate a pipeline system in the state.

The company would lay a line to market gas produced in the western North Dakota pools and processed at the Tioga plant of Signal Oil Co. and Amerada Petroleum Corp.

The North Dakota commission just recently turned down the application of North Dakota Transmission Co. to build a line in the state.

House bills introduced to amend Natural Gas Act

Several bills have been introduced in the House of Representatives that would affect independent natural gas producers.

Representative Ikard (D.-Texas) would exempt sales made by independents from FPC jurisdiction and would require the FPC to allow the interstate pipeline companies an amount "equal to the fair commodity value of such gas in the field where produced" for their own-produced gas (H.R. 3902).

The bill, which has been referred to the House Committee on Interstate and Foreign Commerce, reads in part: "... That Section 1 of the Natural Gas Act is amended by adding at the end thereof the following new section: (d) Notwithstanding any other provision of this act, the commission shall have no jurisdiction over any sale of natural gas at or prior to the point of delivery thereof into the interstate transmission facilities of a natural gas company

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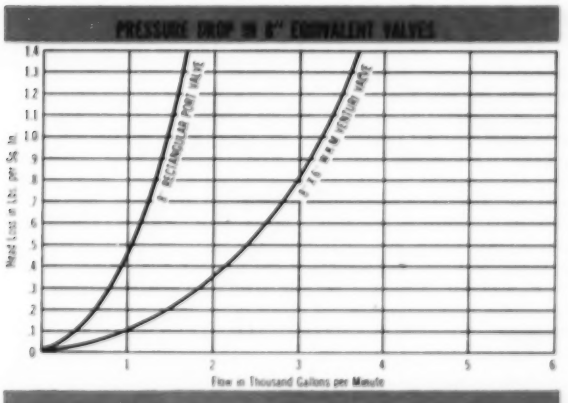
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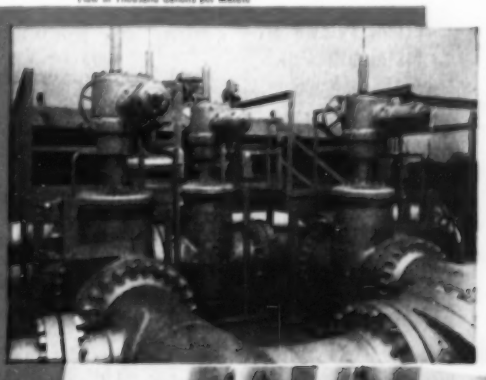

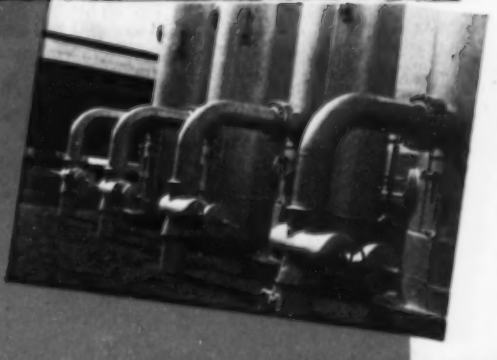

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transporting natural gas in interstate commerce beyond the producing field; but where such a sale is made to a natural-gas company by a person controlling, controlled by, or under common control with, such natural-gas company, and where natural gas is produced by such natural gas company, the rate or charge, subject to regulation under this act, demanded or received by such natural gas company when it thereafter sells such gas shall be determined by including as an operating expense in the rate base for such gas an amount equal to the fair commodity value of such gas in the field where produced."

Another bill, introduced by Representative Rogers, also of Texas, provides that the Natural Gas Act shall not apply to sales of natural gas as an incident of its production and gathering by an independent producer not engaged in the interstate transmission of natural gas.

This bill (H.R. 3703) reads: "Be it enacted . . . That subsection (b) of Section 1 of the Natural Gas Act is amended by inserting at the end thereof the following new section: 'For the purpose of this subsection the term "production or gathering of natural gas" includes the sale of natural gas by the person engaging in its production or gathering, if such person is not engaged in (or affiliated with any natural gas company engaged in) the transmission of natural gas to consumer markets in interstate commerce or the distribution of natural gas to the ultimate consumers.'

"Sec. 2. The amendment made by the first section of this act shall apply only with respect to sales of natural gas occurring on or after the first day of the month following the month in which this act is enacted."

Two other bills have been introduced in the House providing that the FPC must use the original cost depreciated formula in determining the cost of gas for rate-making purposes. (For more details, see Washington Highlights elsewhere in this issue.)

Gulf Interstate enters production field

In order to supplement future earnings from the operation of its new pipeline system, Gulf Interstate Gas Co. has announced plans to drill for oil and gas production.

The 1954 annual report states that Gulf Interstate has acquired ownership of more than 6000 acres of oil and gas leases in Acadia, St. Landry and Evangeline parishes in southern Louisiana, and its subsidiary, Gulf Interstate Engineering Co., owns three-eighths of the working interest in oil and gas leases of 2800 acres in LaFourche and Terrebonne parishes in the state. An 11,000-ft test well is now drilling on the latter acreage and it is expected that the results will be known in 90 days.

Gulf Interstate anticipates the eventual addition of 100,000 hp to the existing 40,000 hp now in use at compressor stations on its mainline. This would boost daily delivery to 575 MMcf, with the additional capacity being provided at a low unit cost in relation to present capacity. This construction program is expected to get under way next year.

Shifts in organizational setup made by the FPC

The actual workers at Federal Power Commission—the men under the commission who do the actual case-work and spade-work and keep the statistics and take in the money—have undergone their first real shake-up since the Republicans theoretically took over the agency two years ago.

The commission acted to streamline its procedures under what seemed to be a general reorganization during February. But, so far, there has been no dimunition of employees, and, the caseload being what it is, particularly since

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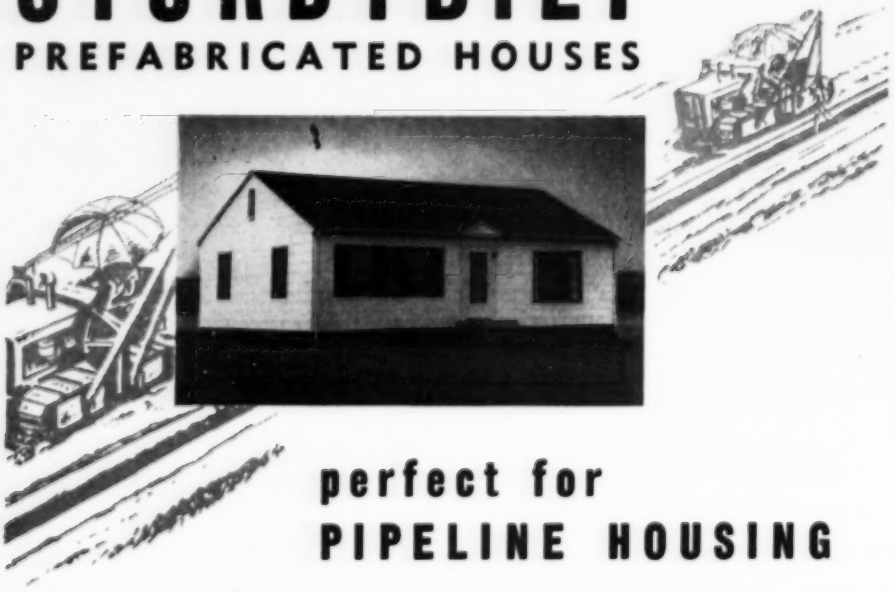

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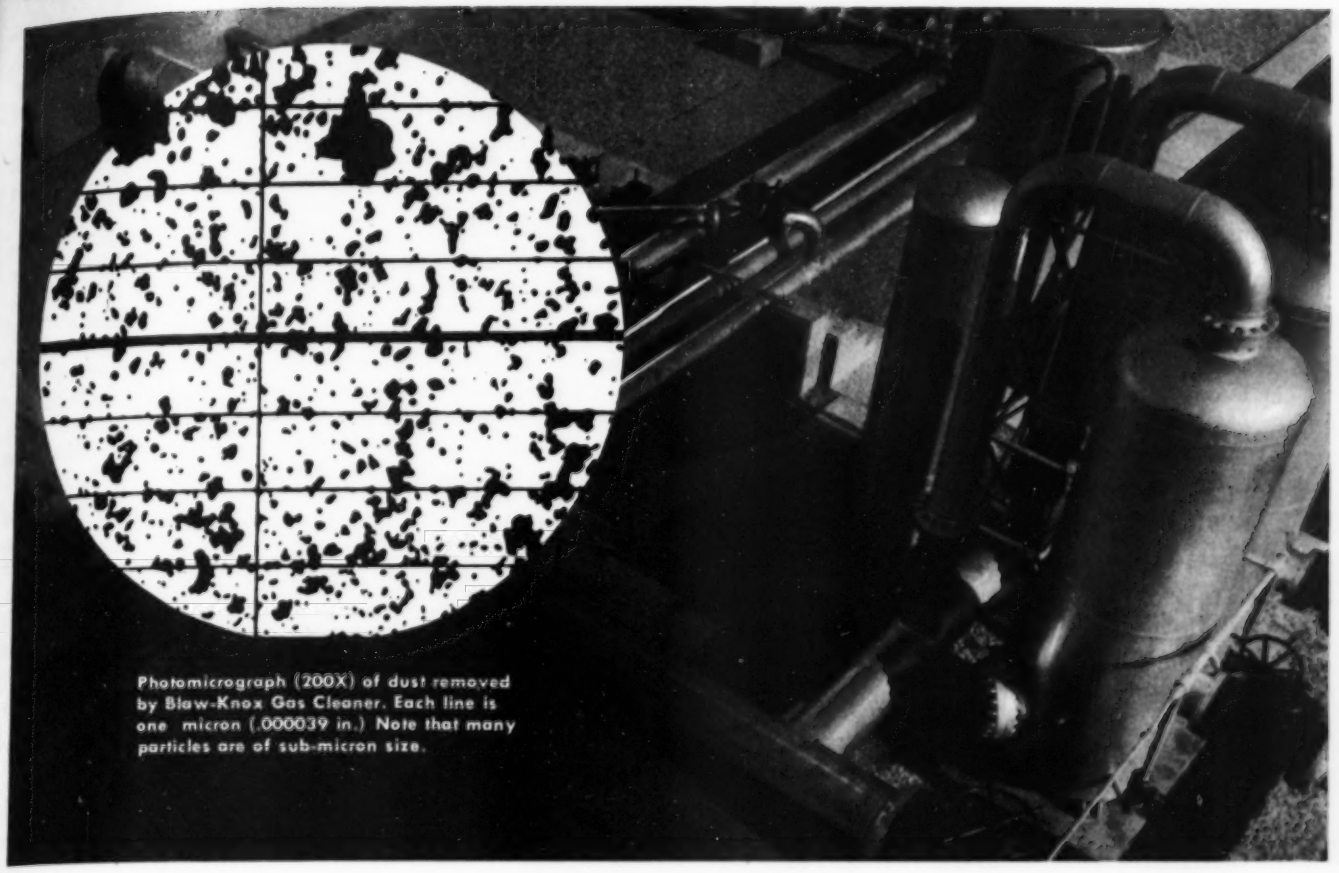

Photomicrograph (200X) of dust removed by Blaw-Knox Gas Cleaner. Each line is one micron (.000039 in.) Note that many particles are of sub-micron size.

dust particles 20 microns and below travel easiest, farthest — do the most damage

Field tests prove Blaw-Knox Gas Cleaners remove even the smallest dust particles

The test of any gas cleaner's efficiency should be measured *not* in terms of the amount of dust collected, but in terms of the quantities entrained in the "clean" gas. The removal of a high percentage of large dust particles is a relatively easy task. However, it is the particle sizes of 20 microns and below that travel easiest, farthest and cause the most damage. Blaw-Knox Gas Cleaners remove even the smallest particles of these dusts.

A large number of field performance tests have been run to determine the dust removal capacity of Blaw-Knox Gas Cleaners. Inlet dust loadings ranged up to 547 pounds per million cubic feet of gas. Tests on the cleaner outlet showed absolutely no dust getting past.

The ability of Blaw-Knox Gas Cleaners to maintain such performance is due to an exclusive operating principle through which each tiny particle of dust is placed immediately in violent, intimate contact with oil. In the expansion separation stages, a major portion of dust-laden oil drops out of the gas stream. An oil-wet, multiple baffle, primary separator catches and agglomerates the remaining tiny wet particles. Finally the gas is scrubbed by an efficient, multiple vane mist extractor.

When you buy, be sure to specify Blaw-Knox, for when you place a Blaw-Knox Gas Cleaner on stream, you're sure to remove even the smallest particles of dust.

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the Phillips decision, no one expects the Eisenhower administration to save any money by being able to fire anyone at the FPC, unless, of course, the person given his walking papers is replaced with a person who calls himself a Republican.

The most important change involves the bureau of accounts, finance and rates, which was abolished. It was replaced with a new bureau of rates and gas certificates.

The accounting and finance functions of the old bureau were transferred to a new office of the chief accountant, headed by Charles W. Smith, formerly chief of the old consolidated bureau. Carl T. Kallina, formerly chief of the gas certificates division, has been named acting chief of the new bureau of rates and gas certificates.

The changes were said to have been made in accord with the recommendations made more than a year ago by a New York management-engineering firm, which had noted that the growth in importance and scope of the old consolidated bureau was tending to make it top-heavy and overcentralized.

A newly created office of administration at FPC, organized during the shake-up, now will coordinate all administrative functions of the commission, including those of the division of personnel and administrative services, and division of budget and finance. This new office is under the FPC's director of administration, J. Kay Lindsay.

The commission also abolished its bureau of law. Instead, it put into operation an office of the general counsel, to which the entire legal staff was assigned. Divisions of electric power, natural gas, interpretation and research, etc., formerly a part of the bureau of law, were abolished. Willard W. Gatchell, FPC general counsel, heads the new office.

FPC officials said that the changes represent realignments and adjustments designed to provide for more efficient and economical operations. Two commissioners dissented, in part, to the reorganization, but it was put into effect nevertheless.

Northern added 52 Iowa towns to line in 1954

Fifty-two Iowa communities were added to Northern Natural Gas Co.'s transmission lines during 1954. The company built 637 miles of new lines in Iowa to provide the additional service, making a total of 2487 miles of lines in the state. Largest of the communities was Waterloo.

Northern Natural is also progressing with its plans for underground storage in Dallas county, 30 miles west of Des Moines. Trial gas pumpings into the underground bank are expected to begin this year. The company also expects to spend approximately $300,000 in 1955 to build about 19 miles of branch lines and eight stations in Iowa.

New tax bill introduced in Texas legislature

A bill has been introduced in the Texas legislature calling for a tax of 1 cent per Mcf of natural gas "brought to the surface of the earth" in Texas. The proposed tax is to be collected from the "beneficial owner," who is described as "the person, other than the owner of the mineral leasehold from which said gas is taken, who acquires title to such gas in this state by virtue of a contract in writing of more than one year's duration by which contract said person has the prior right to a fixed or determinable amount of gas taken or to be taken from the land, leases, reservoirs, or wells from which such as is taken."

Representative Ford, who introduced the bill, said he is assured that the tax

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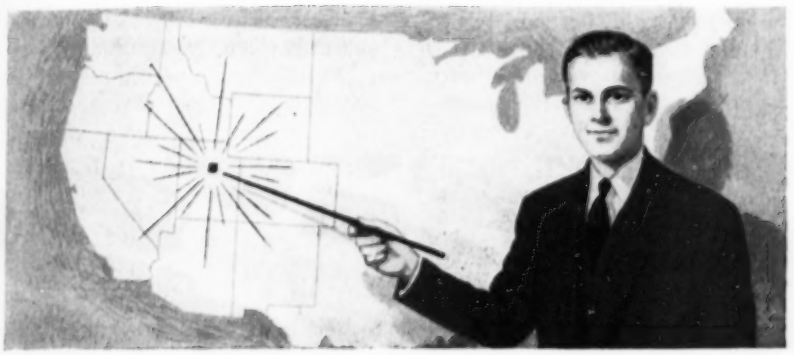

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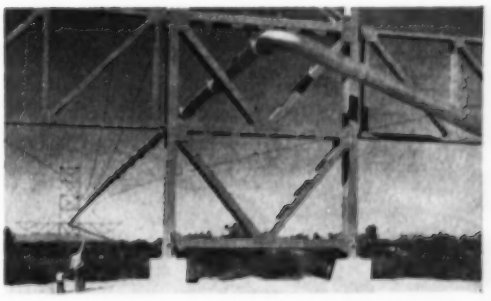
Because United States Steel emphasizes quality control from mine to mill to finished steel . . . its consistently high-quality steel pipe is in demand the world over. A major portion of the world's large-diameter welded-steel gas and oil pipe has been produced by the Consolidated Western process. For 100 years, the Consolidated Western Steel Division of United States Steel has pioneered the fabrication, erection and manufacture of pipe, structural steel, plate products and mechanical equipment—constantly proving that only steel can do so many jobs so well.



PIPELINE OVER THE COLORADO. Bridging the Colorado River between Arizona and California, this 1040 foot pipeline is built from high-strength sections of 30" welded-steel pipe manufactured by Consolidated Western. This important link—connecting the El Paso Natural Gas line to the Southern California Gas and Southern Counties Gas systems—is the second largest of its type in the world.

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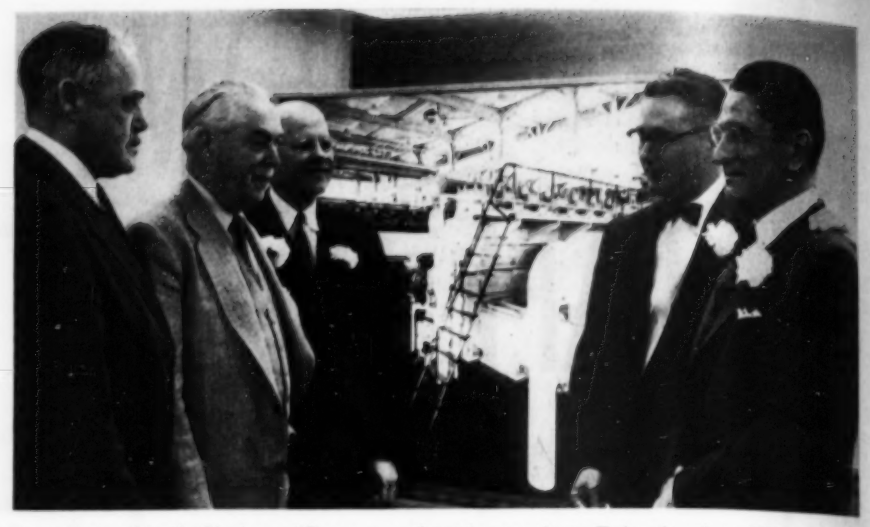
DIVISION

UNITED STATES STEEL

measure is "constitutional" and will impose an impost on gas users who heretofore have escaped taxes. Similar levies in the past have been declared unconstitutional.

Under the Ford proposal, the tax is to be levied upon gas brought to the surface of the earth and "reduced to possession and not returned to an underground reservoir . . . The tax shall be computed upon the total volume of natural gas . . . after the removal or recovery of any water or liquid or liquefied hydrocarbons that may be removed or recovered therefrom . . ."

In the event there is no beneficial owner to pay the tax, it shall be levied against "person or persons owning the working interest in the minerals in the land upon which the well from which such gas is taken is located." The operator of any well is charged with accounting for the gas. For failure to pay, a 10% penalty will be assessed.



Executives of both Clark and Dresser gathered recently in Tulsa for the official opening of the new and expanded facilities of Clark Bros. Co., a subsidiary of Dresser Industries Inc. Clark is the first of several Dresser subsidiaries scheduled to move into the new Sheridan industrial district. From left to right: J. N. MacKendrick, president, Clark Bros.; J. B. O'Connor, executive vice president, and H. N. Mallon, president, Dresser; William H. Barnes, district manager, Tulsa, Clark Bros.; and E. L. Andrews, director of facilities, Dresser.

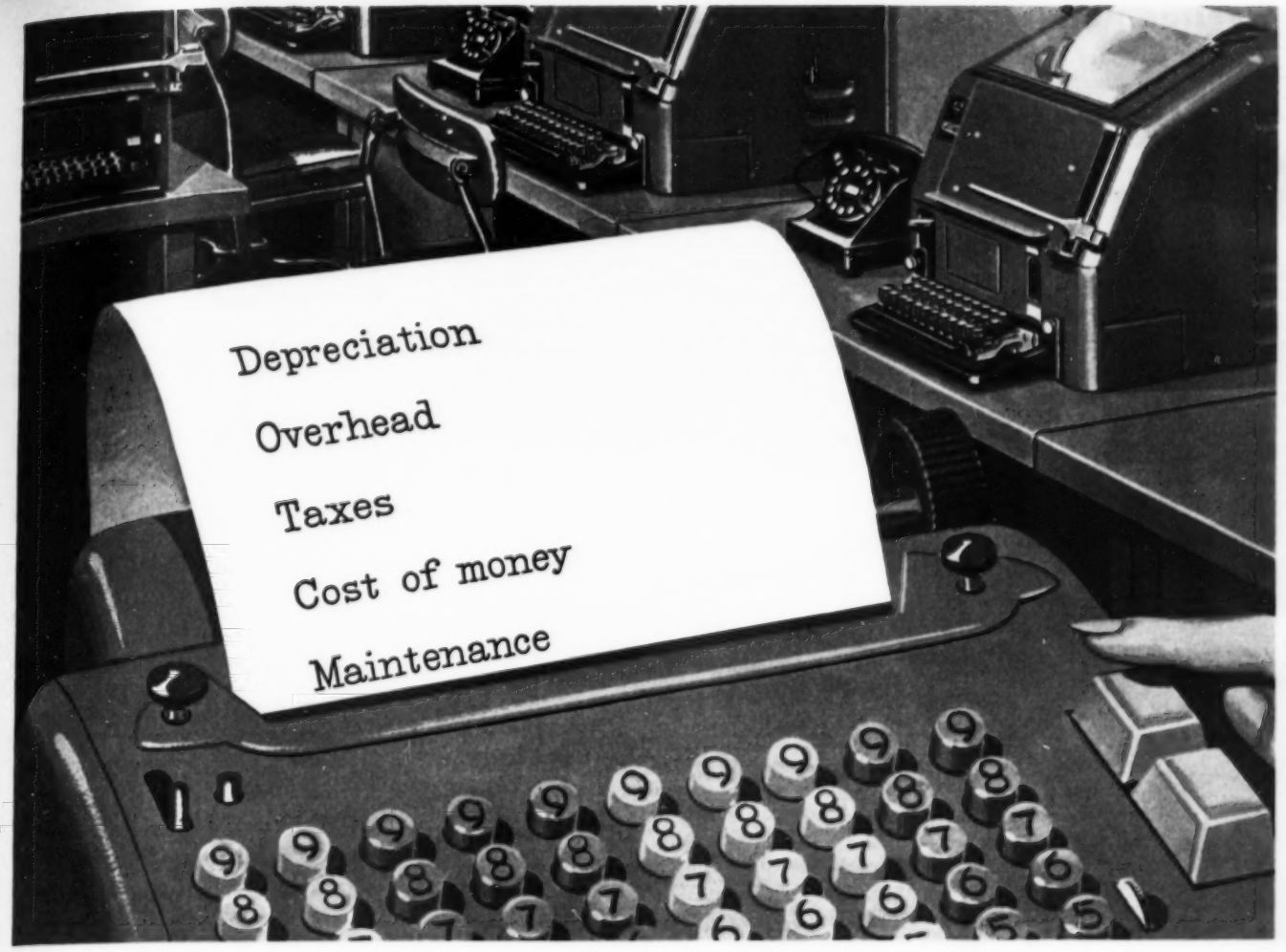
Montana-Dakota's common-carrier obligations ended

A Federal Power Commission presiding examiner has ruled that the obligations of Montana-Dakota Utilities Co., Minneapolis, to render common-carrier transportation of natural gas was terminated by an amendment to the Mineral Leasing Act on Aug. 12, 1953.

In the decision, which is subject to review by the commission, Montana-Dakota was allowed to withdraw and cancel its present common-carrier tariff and a proposed new contract-carrier tariff.

The decision also deals with several other proceedings, all relating to Montana-Dakota's transportation services.

The decision points out that Montana-Dakota discontinued its common-



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Bell System communications are low in cost. You pay only a fixed monthly charge for services and facilities tailored to your exact needs. No more, no less. Your capital is not tied up but left free for income-producing investments in *your* business.

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carrier service Nov. 12, 1954, and has not commenced contract-carrier operations. Examiner Ivins said that Montana-Dakota is now unwilling to institute contract-carrier operations and that there is no authority under the Natural Gas Act to require it to do so.

Under its common-carrier tariff, Montana-Dakota entered into service agreements in 1949 and 1950 for the transportation of natural gas to industrial customers of Mondakota Gas Co., Billings. Subsequently, Williston-Wyoming Associates, and then Industrial Gas Co. Inc., became shippers under these service agreements.

Last May, Montana-Dakota asked the FPC for authority to suspend its common-carrier transportation service to Mondakota and Industrial, and subsequently filed its new tariff to supersede the common-carrier service tariff.

Mondakota and Industrial, meanwhile, applied for a determination of the reasonableness of Montana-Dakota's common-carrier transportation rates. In reply, Montana-Dakota complained that Mondakota, Industrial, and six other shippers have engaged in the sale of natural gas to certain industrial customers without appropriate FPC authorization. Mondakota subsequently filed an application for a certificate covering an industrial sale, but Examiner Ivins ruled that it should be dismissed for lack of jurisdiction. The decision also terminates all of the other related proceedings.

Boiler fuel sale allowed Southern Natural

Southern Natural Gas Co., Birmingham, has been authorized to sell natural gas for use as boiler fuel to South Carolina Generating Co., Columbia, S. C. (Docket G-2499.)

Under the authorization, Southern Natural will build approximately 2.2 miles of 8⅝-in. pipeline near North Augusta, S. C., extending to the generating company's Urquhart power plant on the Savannah river near Beech Island, S. C. Estimated requirements of the generating plant are a maximum of 60 MMcf of natural gas per day, with an annual total of approximately 10,072,000,000 cu ft. Estimated cost of the facilities to be built by Southern Natural is $125,400.

Exclusive option for gas granted by Saudi Arabia

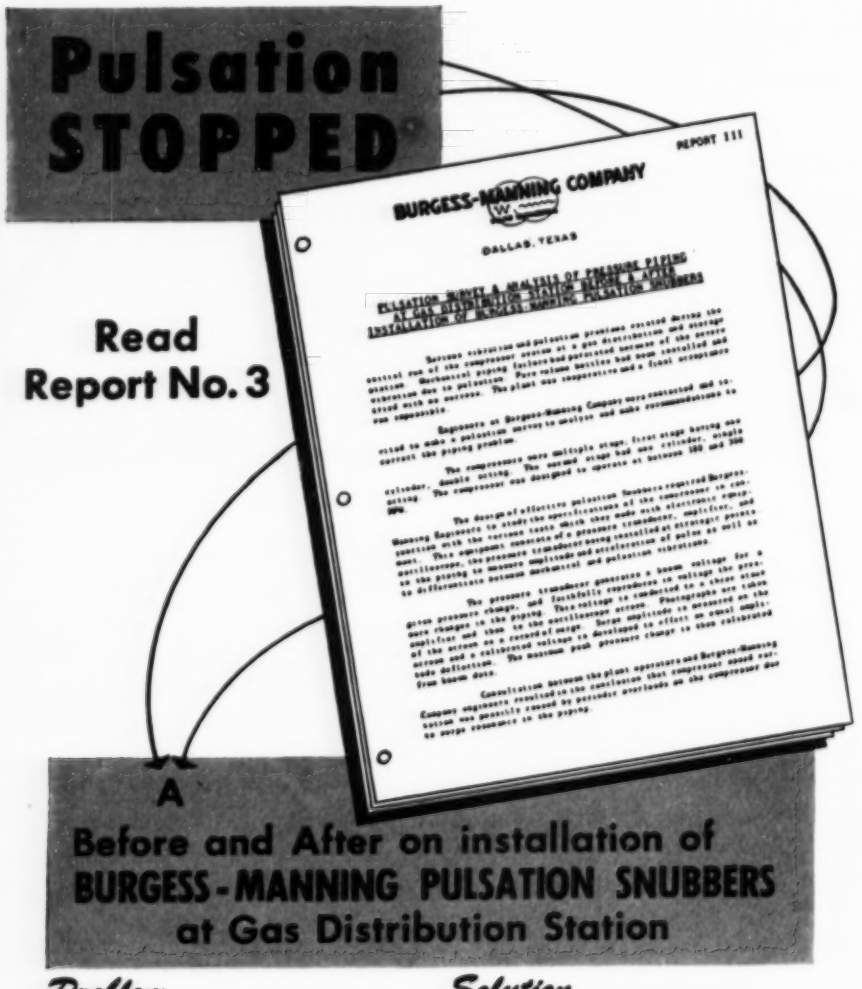
International Development Services, New York, has been granted an exclusive option for the gas produced in Saudi Arabia. The agreement that the non-profit, technical service organization has with the Saudi Arabian government gives it 14 months to finish a study of projects using surplus gas and to set up a financial organization to carry out the plans.

Projects under study by International Development include channel black, sulfur, urea, power, and liquefaction, the latter an untried method of shipping gas long distances by barge or tanker in the liquid state.

Kentucky-West Virginia plans $1.3 million line

Kentucky West Virginia Gas Co., Pittsburgh, is filing applications with the Federal Power Commission and the Public Service Commission of Kentucky for approval of the construction of a $1.3 million 12-in. gas pipeline from Osborne Gap to Maytown. This pipeline will be used to carry up to 12.5 MMcf per day of gas to be purchased from Clinchfield Coal Corp. under a recently signed contract. It will also carry gas produced by Kentucky West Virginia from its gas wells in Kentucky.

Equitable Gas Co., Pittsburgh, of



A

Before and After on installation of BURGESS-MANNING PULSATION SNUBBERS at Gas Distribution Station

Problem

Plant inoperative and final acceptance run impossible due to serious vibration and pulsation. Mechanical piping failure persistent.

Solution

Survey was made by Burgess-Manning Engineers and Burgess-Manning Pulsation Snubbers were designed to meet the specific need of each of 2 compressor stages.

PULSATION REDUCTION IN TOTAL POUNDS AMPLITUDE

1st Stage Discharge.....41 lbs. to 7.3 lbs.
2nd Stage Intake.....30.3 lbs. to 6.7 lbs.
2nd Stage Discharge .....220 lbs. to 18.95 lbs.

Report No. 3 is yours for the asking — Write.

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Sound Engineering

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ONE FIFTY

Performance-wise, as well as appearance-wise, this is the finest 2-way radio equipment that RCA has ever offered. Engineered for top performance, clearest voice reception, minimum maintenance and low-cost servicing, its features represent planning that is years ahead.

Among the built-in advantages you'll welcome now and benefit from in the years to come . . .

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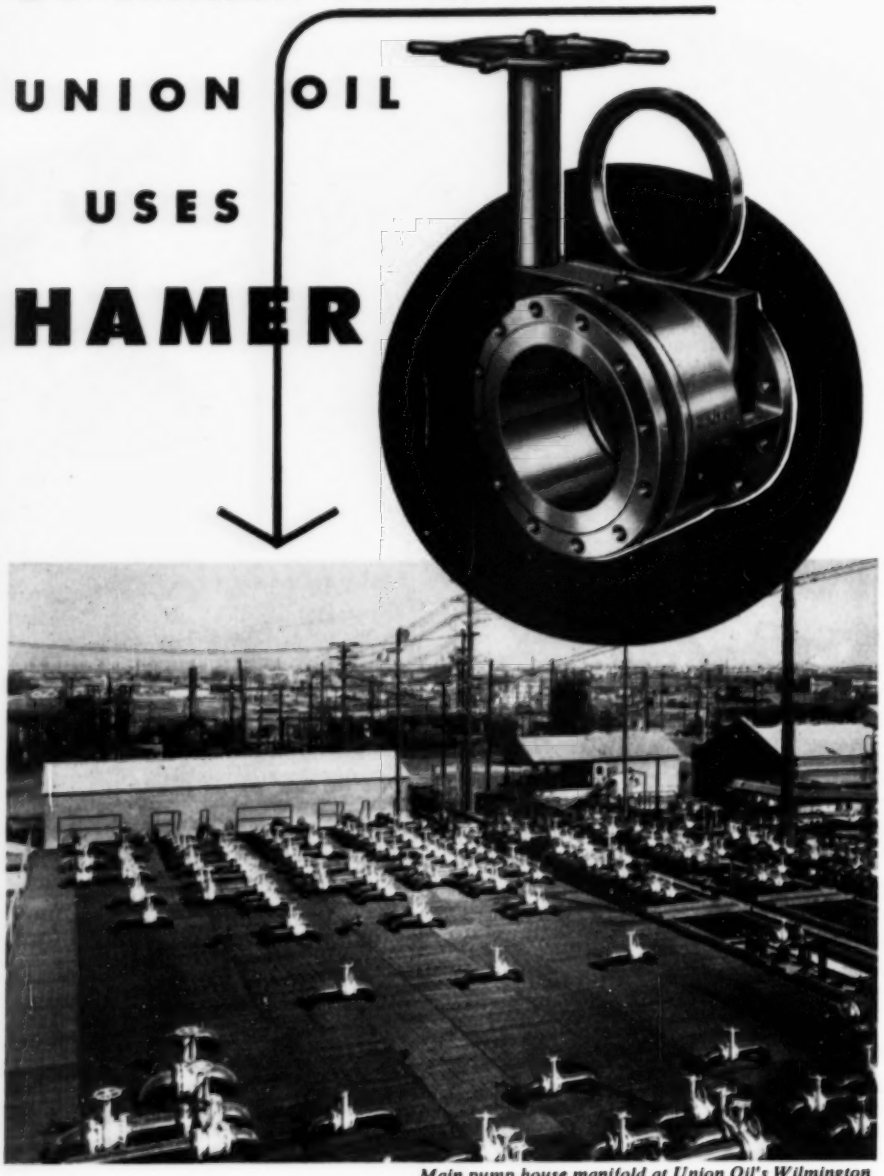

Main pump house manifold at Union Oil's Wilmington refinery uses hundreds of Hamer Line Blind Valves.

HAMER *Visible Shut-off* LINE BLIND VALVES

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Custom-crafted, Hamer Plugs welcome the tough applications where ordinary plug valves fall short. Standard dimensions. Readily installed.

With literally hundreds of different hydrocarbons moving through the refinery, Union Oil can't possibly risk product contamination. That's why they use Hamer Line Blinds. Hamer Line Blind Valves not only provide a permanent, positive leakproof shut-off, but are unsurpassed for long service-life and lasting safety. In addition Hamer Line Blinds are fast, simple to operate. One man can open or blind a line in one minute. Costly down time is reduced. Operational efficiency is vastly increased.

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pipeline news • *Cont'd.*

which Kentucky-West Virginia is a subsidiary, also announced the formation of a new subsidiary, Kentucky Hydrocarbon Co., which plans to construct a hydrocarbon recovery plant near Maytown to process part of the gas produced by Kentucky-West Virginia. It is estimated that this plant and related facilities will cost approximately $9 million and will begin operation about Jan. 1, 1957. The plant will be capable of producing approximately 10 MMcf per day of ethane, propane, butane and natural gasoline in liquid form. These products will be sold under a long term contract and delivered by pipeline to Carbide and Carbon Chemical Co., a division of Union Carbide & Carbon Corp., for utilization in its South Charleston and Institute, W. Va., plants.

FPC rejects one Phillips increase, suspends another

On the rate scene with the independent producers recently, the FPC rejected the conditional filing of a $585,000 rate increase by Phillips Petroleum Co. for natural gas sales to Michigan-Wisconsin Pipeline Co. and suspended a $918,000 increase proposed by Phillips on sales to the same company.

The commission also accepted 67 rate increases totaling $378,889 annually filed by independent producers. Of this total, increases amounting to $107,590 yearly are tax increases.

In another action, the FPC allowed 153 rate increases, including 117 tax adjustments, proposed by independents to go into effect, but suspended one other filing for higher rates. These increases total $926,808. They include 11 favored nation or periodic increases totaling $216,622 per year; 25 increases, amounting to $18,338 annually, which were considered *de minimis*; and 117 increased based on revisions in the Texas and Louisiana gathering and production taxes, totaling $691,848 yearly.

Heselton reintroduces safety requirement bills

Duplicates of bills he proposed last year have been introduced by Representative Heselton (R.-Mass.) in the House of Representatives dealing with safety requirements for gas companies and with studies with respect to interstate compacts relating to conservation of gas and oil.

H.R. 433 would authorize the FPC to "prescribe such requirements, restrictions, and conditions with respect to the construction, extension, operation, and maintenance of transportation facilities

Sections of this recently completed 462-mile products line of the Oklahoma-Mississippi Products Line, Inc., running through Arkansas from Duncan, Okla., are corrosion-protected by Transhield.

Johns-Manville TRANSHIELD® ASBESTOS PIPE LINE FELT

goes on fast, restricts soil stress, cuts maintenance

Transhield Asbestos Pipe Line Felt meets the need for a felt that is economical yet effective in all ordinary soil conditions.

Designed for easy, high-speed application by modern machine methods, Transhield is strong, light in weight, and highly tear-resistant. Longer length rolls increase application speeds since fewer stops to replace rolls are required. Transhield's highly desirable characteristics are attained through an innovation in felt construction. It consists of a lightweight coal-tar saturated asbestos felt, reinforced with continuous glass yarns parallel-spaced on ¼" centers.

Because Transhield is a continuous membrane between the pipe line enamel and the soil, it works effectively toward preserving a continuous protective film of enamel on the pipe. It guards the enamel during construction and, after installation, it reduces the cold flow of the enamel, acting as a surface barrier to restrict soil stress.

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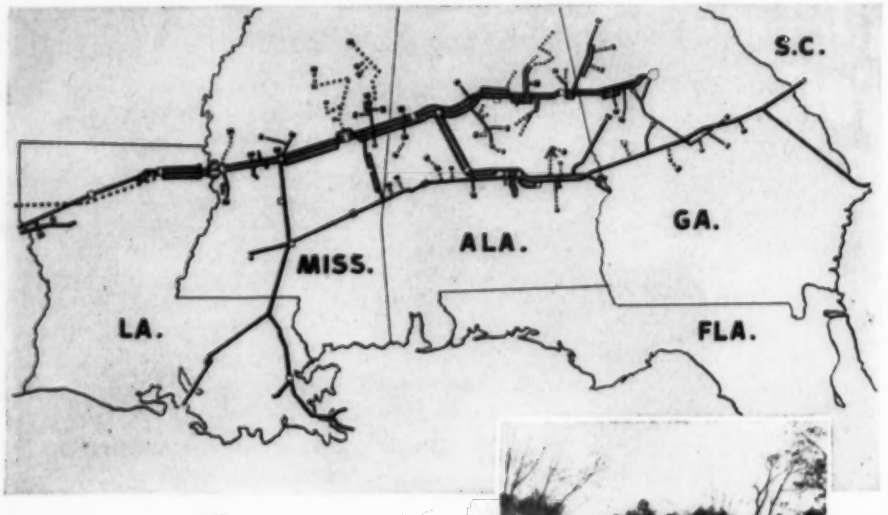
For further information about Transhield, write to Johns-Manville, Box 60, New York 16, New York; in Canada, 565 Lakeshore Road East, Port Credit, Ontario.

Johns-Manville PRODUCTS FOR PIPE LINE PROTECTION

Congratulations to

SOUTHERN NATURAL GAS COMPANY

. . . a leader in southern expansion and still growing



MILES OF PIPE

at end of	*miles*
1947	1899
1948	2120
1949	2218
1950	2625
1951	2840
1952	2970
1953	3855

Glass Fibers Inc. is proud to number Southern Natural Gas Company among its valued customers

GLASS FIBERS INC. congratulates forward-looking Southern Natural Gas Company on its vigorous pipeline expansion program. As is well known, the cost of constructing an underground pipeline is tremendous. The cost of repairing or replacing it is sometimes even greater. Yet, for less than ½ of 1% of the original investment, Blue Flag-reinforced enamels will preserve a pipeline for years beyond its normal life. For a new folder on Glass Fibers' pipe wraps, write to Glass Fibers Inc., 1810 Madison Avenue, Toledo 2, Ohio.

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GLASS FIBERS *INC.*

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pipeline news • *Cont'd.*

of natural gas companies as, in its opinion, are necessary for the promotion of safety."

H.R. 431 would amend the Natural Gas Act to require the FPC to report to Congress regarding the effect and operation of state compacts dealing with the conservation, production, transportation, or distribution of natural gas. The third bill, H.R. 432, calls upon the Attorney General to make "a continuing study of action taken" under the legislation authorizing the creation of the Interstate Oil Compact Commission "with particular reference to whether any such action is inconsistent with the purposes of, or contrary to the limitations and restrictions contained in, such compact."

Coal company to transport gas for transmission firm

Clinchfield Coal Corp., Dante, Va., has filed an application with the FPC (Docket G-7586) proposing the construction of 16 miles of 12-in. line to transport gas produced in southwestern Virginia for sale to Kentucky-West Virginia Gas Co., Pittsburgh.

The application first requests the FPC to disclaim jurisdiction, but in the alternative asks the commission to issue a certificate authorizing the construction and operation of the line.

Clinchfield, which said it is primarily engaged in the production and sale of coal, plans to produce natural gas in Dickenson county and transport it through the proposed 16-mile line to a connection with facilities to be built by Kentucky-West Virginia at the Kentuck-West Virginia state line near Osborne Gap, Ky.

Estimated cost of the proposed line is $785,000. Clinchfield said that it would be capable of delivering 16,010,000 cu ft of natural gas per day. Clinchfield's contract with Kentucky West Virginia calls for a daily contract quantity of 12.5 MMcf.

Natural gas permit map of Canada available

A revision of the petroleum and natural gas permit map has been completed by the Department of Mineral Resources of Saskatchewan. The permit map, which uses color for the first time, illustrates in eight color designs the 20 separate permit holders.

Prepared as of Dec. 15, 1954, the map is 54 in. by 33 in., with scale of 12 miles to the inch. Permit numbers, sizes, and dates, as well as holders of permits are listed. Maps may be ob-

You Can Lead a Horse to Water But . . . . . .

WHEN the United States Supreme Court throttled the gas producer with price fixing, several interstate pipeline projects were postponed. The builders still want to construct them but they no longer have assurance of an adequate gas supply. Rather than sell under prices fixed by the Federal Power Commission, many producers declined to make contracts.

In other instances, some producers discontinued deliveries under existing contracts which provided for such action in case of Federal price fixing. Some who fought for the price-fixing decision promptly besought the Federal Power Commission to compel producers to continue deliveries. This seems like another issue for the courts.

The man with gas reserves not under contract cannot be compelled to enter into a contract, which means the construction of interstate transmission systems will move at a slow pace until the Natural Gas Act is clarified.

What will these gas producers do with their gas? Those who anticipate that the producer will, in time and of necessity, have to submit to price fixing should have a look around. Two Southwestern plants, one for making chemicals, the other for aluminum ore reduction, use more gas per day than all of the homes in Detroit, Milwaukee and Kansas City, combined.

Natural gas is sometimes called the "world's outstanding raw chemical." It is used in making nylon salts; can be converted into acetylene, and its hydrogen content can be combined with nitrogen (from the air) to make ammonia. As a low-cost, efficient fuel for our homes, our industries and our people, natural gas has no superior.

Rather than sell it at a government-fixed price, many producers are determined to use or sell it within the state where it is produced. The finished chemicals made from and with it can move across state lines without price control. Why not natural gas, whose benefits are anxiously sought by so many millions of Americans?

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tained at $5 each, from the Department of Mineral Resources, Government Administration Bldg., Regina.

Kuykendall asks Congress for 19 new powers

In his appearance before Congress early in February, FPC Chairman Kuykendall requested 19 new powers in the regulation of the gas and electric industries.

These include requests for power to regulate proposed security issues of gas pipelines, to suspend proposed rate increases on the resale of gas for industrial use, to require payment of reparations for gas and electric overcharges, to veto any proposed transfer of reserves by gas pipelines, to prescribe safety regulations for gas companies, to control gas importers and exporters, to require the interconnections of gas and electric systems where necessary, and to require the U. S. to reimburse state or local governments or private power companies when they construct upstream power facilities that indirectly benefit the Federal government.

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WEAR COMPENSATING
PIPE-LINE SCRAPER CUP
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BIG INCH DESIGN
SPRING-LIKE ACTION OF CUP LIP IS . . . WEAR COMPENSATING
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FLEXIBILITY OF TAPERED LIP MAINTAINS TIGHT SEAL IN . . .
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TGT amends plans already approved by commission

Tennessee Gas Transmission Co., Houston, has filed an application with the FPC seeking authority to construct a 370-mile, 30-in. line from near Agua Dulce in south Texas along the shore line of the Gulf Coast of Texas and Louisiana to near Kinder in south Louisiana. This new line will be built in substitution for pipeline and compressor facilities previously authorized by the FPC between Agua Dulce and Natchitoches, La., but not yet constructed.

The $35.4 million line will be capable of transmitting 270 MMcf of gas per day and will pass through an important part of the Gulf Coast supply area where the company now has no facilities, thus making gas supplies available both from fields on shore and from the off-shore tidelands area where exploration has only recently begun.

Michigan-Wisconsin exempt from Iowa use tax

A district judge has ruled that Michigan-Wisconsin Pipe Line Co. does not have to pay $17,074 in use tax assessed on some of its equipment by the Iowa Tax Commission.

The transmission company had claimed in a suit that the equipment was exempt from the tax under provisions of Iowa law granting exemptions for equipment used in interstate commerce. The judge ruled that the equipment involved was moved into Iowa for use in the pipeline, but was assessed before it was placed in use.

The commission contended that the pipeline company was not entitled to the exemptions because of certain restrictions in the law. The judge ruled, in effect, that Michigan-Wisconsin should be entitled to a reasonable time to install the equipment as part of its interstate facilities.

TransCanada signs 20-year contract with Union Gas

The first—and one of the most important—Canadian natural gas contracts required by Trans-Canada Pipe Lines Ltd. has been signed with Union Gas Co. of Canada Ltd., according to a joint announcement by N. E. Tanner, president of the pipeline company, and David P. Rogers, president of Union.

The contract calls for 20-year deliveries of Alberta gas to Union's system in southwestern Ontario. Over this period, Union will purchase in excess of 300 billion cu ft of natural gas from Trans-Canada; deliveries will start soon

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Dow's new high potential anode cuts cost of corrosion protection

4 new GALVOMAG anodes do the job of 5 conventional anodes ... to reduce your original investment and installation cost, too

Let's take a new look at cathodic protection. Dow's new high potential anode, called GALVOMAG*, has 25% more current output than conventional anodes.

To put it another way—4 anodes now do the work of 5. It's easy to see why your installation costs in time and labor will go down in proportion.

In addition, economical protection in high resistivity soils can now be achieved. GALVOMAG's greater current output extends its use into ranges previously impractical for magnesium anodes.

Your Dow anode distributor is ready with all the facts and figures on GALVOMAG. Call him today. THE DOW CHEMICAL COMPANY, Midland, Michigan. *Trademark

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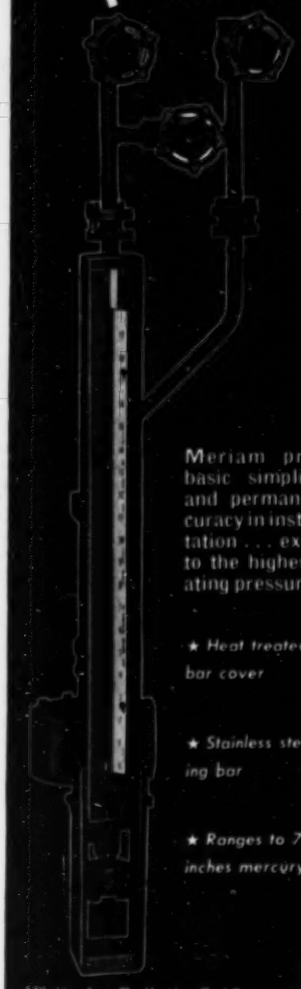
at highest working pressures

At pressures up to 2000 psi, this Meriam Manometer provides critically accurate flow or differential pressure measurement. Constructed of solid bar stock steel, all parts are precision fitted, hand lapped. Each unit is cold hydraulic tested to 5000 psi.



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. . . for pressures, vacuums, flows, liquid levels.

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pipeline news • *Cont'd.*

after the Trans-Canada line reaches Toronto. Construction on the 2250-mile Alberta-Montreal pipeline is scheduled to start this spring and Alberta natural gas is scheduled to arrive in Toronto in November 1956.

A new large diameter pipeline, costing in excess of $14 million, will be constructed from the Dawn underground storage field, near Sarnia, to a point just north of Hamilton. When Alberta gas arrives, a connecting line will be built from Hamilton to Sheridan, the area terminus of the Trans-Canada line.

Mr. Rogers estimated the contract involves purchases amounting to more than $100 million over the 20-year period. "This will result in benefits of natural gas being made available to many thousands of citizens in southwestern Ontario for the first time."

GAS pipeline notes

In rejecting an application by Humble Oil & Refining Co. to sell gas to Mississippi River Fuel Corp., the FPC pointed out that the contract for the sale of the gas is actually between Stanolind Oil & Gas Co. and Mississippi, and that Humble is not a party to the sales contract. Humble owns a working interest in a unit operated by Stanolind, which has authority to market Humble's proportionate part of the gas produced from the unit.

Kaiser Steep Corp. has purchased the plant and facilities of Union Steel Co., Los Angeles.

J. F. Pritchard & Co. of California, Kansas City, Mo., has appointed two new sales representatives in southern U. S. Brownlee-Morrow Engineering Co., Birmingham, cover the state of Alagama and western Florida. Rittelmeyer & Co. Inc., Atlanta, covers Georgia, eastern Tennessee, and eastern and southern Florida.

Lone Star Gas Co., Dallas, has started construction on a 22-mile, 18-in. line from which deliveries will be made to the Texas Power & Light Co.'s steam-electric generating station under construction in Collin county. Costing in excess of $500,000, the new line will have a 100-MMcf per day capacity.

Discovery in Israel of the first natural gas deposit which may have commercial possibilities has been confirmed by officials of the Israel-American Oil Corp., which made the find near an industrial area just northeast of Tel Aviv

GAS new pipeline products

(For additional information, use coupon on page 98.)

15 Protective Tapes

Qualities of polyvinyl chloride—high physical and dielectric strength, stability and aging qualities, resistance to acids, alkalies and soil stress, and low moisture absorption—are now available in the new Plicoflex protective tapes.

Plicoflex No. 330 is for use with any one of three adhesives: butyl rubber coal tar resin asphalt base, and special neoprene compound base resistant to the action of crude oil and petroleum solvents. Available in black, white, and six brilliant colors, Plicoflex tapes provide a perfect bond to irregular pipe surfaces, as well as a moisture-proof seal at the helix of the spiral, whether applied with or without adhesives.

Plicoflex Inc.

■

16 Communication equipment

Explosionproof inter-communication equipment for hazardous industrial areas is now available. Calls can be freely made from any area of a plant to any other area, regardless of the fact that the calls originate or are received from a hazardous or safe area.

Manufactured by Executone Inc., and equipped with explosionproof or dust-tight Condulet switches, explosionproof inter-com stations are installed at hazardous production areas where the presence of either flammable gases or vapors, or combustible dusts, prevents the use of ordinary inter-com equipment.

Executone employs four types of explosionproof or dust-tight selector switches for use as hazardous areas.

Executone Inc.

■

17 Map file

Maps and large tracings can be filed in a double-door universal Tubefile manufactured by Scott-Rice Co. The file pictured (MT-4) has 112 tubes 36 in. long. Also available is Model MT-2, which has 54 tubes.

Tubefiles are rigid steel bins which are installed in standard steel cabinets.